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•

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ONE SHILLING

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NITROGEN IN PLANTS

THE EFFECT OF MILK YIELDS AND PASTURE VALUES ON THE COST OF BUTTERFAT PRODUCTION

SOME NOTES ON EAST AFRICAN SHEEP FARMING

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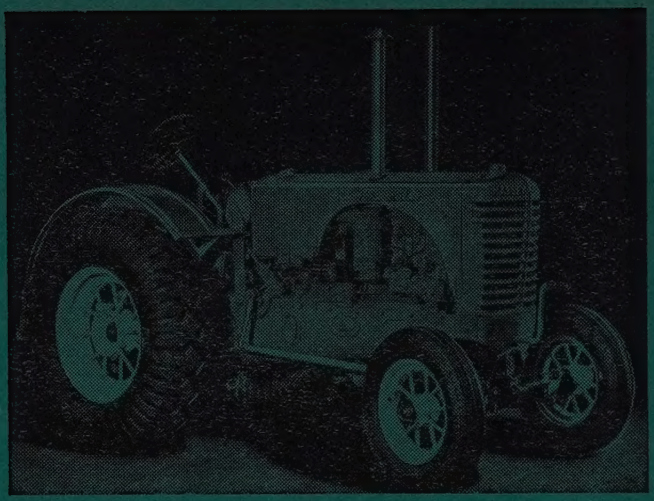

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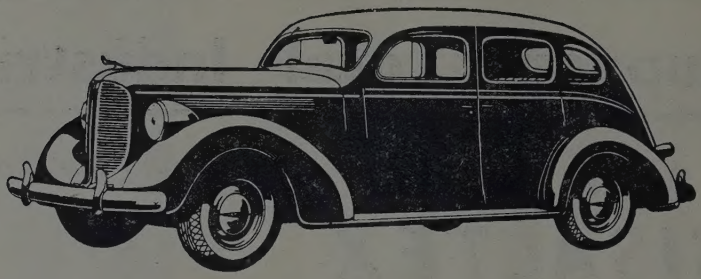

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Readers are reminded that all agricultural inquiries, whether they relate to articles in the Journal or not, should be addressed to the local Direcor of Agriculture, and not to Amani.

MAN, FOOD AND THE FARMER

We have previously drawn attention (May, 1937) to recent advances in the science of nutrition, to the increasing applicability of such knowledge to man's needs, and particularly to the needs of the native of the tropics. We also referred to the interest taken in this subject by the Secretary of State for the Colonies. One of the fruits of this interest is the report on "Nutrition in the Colonial Empire" which has been prepared by a Committee of the Economic Advisory Council, and recently issued by the Colonial Office. This report summarizes information supplied by the forty-eight British Colonial Governments, discusses the deficiencies and potentialities of colonial diets, and lays down general principles for both present and future action and investigation. It is of great interest and importance not only to administrators but to all those who have any concern in the growing of food, its marketing, and its sale or issue to the African.

Basic problems, such as the inefficiency of labour in the tropics, the low standard of living of the native, and infantile mortality, are intimately concerned with diet, and no scheme which does not include such problems in its scope can get to the root of dietetic improvement.

The first condition of adequate nutrition is of course that there should be enough food, and until recent years the attention of workers on nutrition was largely concentrated on this aspect of feeding. But the recognition of the

importance of quality has brought complexity into what had hitherto been a comparatively simple mathematical equation. It has also led to a great measure of elucidation of the many deficiencies in health, and actual disease, which may arise from an unbalanced diet. Among such deficiencies some of the chief arise from the absence of animal protein, namely milk, meat and fish, from the diet. A deficiency of animal protein may, however, in part be made good by the provision of a sufficient variety of vegetable foods, and in this connexion one of the most striking facts, in the Committee's opinion, is the extent to which colonial peoples are dependent on a single staple food. The growing and use of a greater variety of crops is largely dependent on women, and great emphasis is laid on the importance of the education of women, who control not only food production but its harvesting and all stages in its preparation. The importance of women in the better feeding of children is also emphasized. The Committee points out the pre-eminent position of milk as a food and remarks on the almost complete absence of milk and other animal products from most tropical dietaries. The report also stresses the value of domestic herds in preserving soil fertility.

In any case, but particularly in view of the predominant part which a single staple food plays in the diet of most African peoples, the composition of soil and the presence or absence of fertilizers play a great part in the provision of adequate quantities of minerals. Whether crops are eaten directly or are converted by animal husbandry into the more valuable animal protein, the mineral constituents come from the soil and must be supplemented if deficient. Reference is made in this connexion to the need for widespread soil analyses.

The third respect in which tropical diets may be, and almost universally are, deficient is in the group of vitamins, contained but slightly in the staple foods. The increase in food variety which the report recommends would be one step in remedying this sort of deficiency; for instance, such crops as soya beans and groundnuts have a much greater vitamin value than the cereals and cassava, as well as having a greater energy yield per acre. Preparation and storage of the food products are also of great importance, not less in the case of the cereals than in that of other more essentially valuable food crops. Lightly milled maize meal has a higher vitamin content than has maize flour, beans must be protected from weevil in order to preserve the essential germ, shade-dried greenstuffs have little less value than fresh ones whereas sun-drying destroys to a great extent the vitamins contained in them. Such suitably dried green foods could play a much larger part than they do at present in remedying the deficiencies which occur, particularly towards the end of the season, not only of vitamins but also of such essential minerals as iron and calcium.

"The main causes of malnutrition in the Colonial Empire are, in our view, first, that the standard of living is often too low; secondly, that there exists great ignorance coupled with prejudice." Improved nutrition is largely dependent upon economic development, but in the meanwhile and even at the present economic level there is much room for present action. Governments, which are among the largest employers of labour, could provide an example of adequate and balanced feeding. Planters could do the same, and could moreover not only provide every permanent labourer with a garden to cultivate, but "perhaps even require him to make full use of it." Not only employers, but all those who have

an influence on the nutrition of others—officials, educationalists, missionaries and agriculturists—should gain an appreciation of the principles of nutrition. Only so can the essential co-operative effect be instituted and achieved.

The first need is to foster the growth of internal trade. Having developed the cultivation of the necessary crops, in some cases perhaps by the guarantee of a stable price, the development of internal trade will do much to mitigate the worst effects of economic depressions and so maintain the nutritional standards of the general population. Recommended measures to achieve this end are the establishment of marketing centres, the provision of storage facilities, and simple but adequate communications. Apart, however, from internal production, another contribution to the provision of abundant cheap supplies of nutritive foods could be made by making imports of such foods duty free.

The later sections of the report discuss the educational measures which should be adopted in attempting to deal with the conservatism, prejudice and ignorance which are perhaps the chief obstacles to be overcome in effecting improvements in diet. As in so many other undertakings it is concluded that the best means of effective progress is to be found in concentrating the effects of different departments in one area; and there is much to be said for such a recommendation. It is also recommended that local nutrition committees should be formed, but such organizations might be too restricted in scope, and would not in all probability long survive their first impetus. Local co-ordinating committees, which should include the improvement of nutrition in their activities, have long been needed. Special emphasis is rightly laid on the importance of ante-natal and infant care from the nutritional standpoint, especially with regard to the correction of the appalling stuffing (it can be given no other name) which takes the place of infant feeding in the case of most African babies.

The fact that assured results of nutrition research have been effectively applied in practice to such a small extent is, in part, due to the lack of knowledge of local crops, diets and methods of preparation. Laboratory studies must in practice be confined to a few large centres, but the chief need is for field survey work amongst all types of the community. The first of such surveys, financed by the Medical Research Council, is now being carried out in Nyasaland, and we hope that this will be but the forerunner of many others.

We commend this excellent report as food for thought and as a basis of action.

FOOD STORAGE

Those lilies of the East African field, the womenfolk of the tribe, undoubtedly toil; they spin not, but they do gather into barns—not such as are described by lecturers on farm buildings in agricultural colleges, but receptacles of one kind or another which fulfil essentially the same function. In a series of notes contributed from Kenya and brought together in this issue under the title "Native Methods of Food Storage", there will be found accounts of a variety of structures, utensils, and methods of safe keeping that solve for the small family unit of certain Kenya tribes the problem of carrying over the produce of each harvest towards the time of scarcity that is always a risk until the next is garnered. It is a subject of considerable possibilities, and we hope to hear more about it from time to time from contributors in other parts of East Africa who have opportunities of studying such practices at first hand. Readers will recall the description of a Nyasaland experiment

in communal grain storage in our January number of this year. No one can travel in the parts of Uganda where finger millet is a staple grain without being impressed by the organization that has been developed under the native administrations for the establishment of famine reserves, of this foodstuff chiefly, at each county and *gombolola* (parish) headquarters. The erection and maintenance of these larger-scale stores involves the same problems of proofage against pests and the weather as do the devices employed by the family unit, though they also require a standard of co-operative willingness and social loyalty whose maintenance is perhaps a problem of difficulty in another field. It seems that in particular cases the entomological aspect and the sociological one converge: a deterrent powder admixed with the grain is apparently effective against immature forms of the human weevil (see Mr. Chambers' remarks on children).

Another direction in which the subject leads interestingly is in the effect of the food store upon the ground plan of the village. A number of the *Geographical Review* received recently (that for October, 1938) contains a fascinating series of air pictures of the African scene taken in the course of a journey from Cape to Cairo. (Incidentally, the numerous views of Rhodesian and Kenya farms from above included in this series illustrate graphically the changes that the European in Africa brings about locally—very locally—in the scenery he has settled in.) The houses of a stockade-enclosed village at Juba in the Sudan "seem to be divided about equally between grain storage bins elevated on stilts, and living quarters". Other pictures from the Kafue Valley in Rhodesia show the same thing, and it is undoubtedly true of many a village in East Africa. The total requirement in building poles, thatching material, and labour for this purpose must be a comparable quantity with that for the mere provision of shelter. The fact is, of course, that the African's farm-steading is his cottage, and his household out-buildings fall very much within the province of those who are interested in his agricultural methods and their improvement.

G. M.

NITROGEN IN PLANTS

"Some experiments made by Boussingault," said *The Athenæum* of February 9, 1839, "show that trefoil, cultivated in a soil previously calcined to a red heat, admits a certain quantity of nitrogen into its organization, which probably proceeds from the atmosphere. On repeating the experiment with peas, the peas, with no other nourishment than that which had been derived from water and air, have flowered and yielded perfect seeds, and the nitrogen was more than double in quantity to that originally contained in the peas. On comparing these experiments with those made on oats, etc., it appears that only certain plants are apt to derive nitrogen from the air, but the manner in which this elementary body fixes itself in vegetables is not known."

—Extract from *Nature*, 4th February, 1939.

(*Note.*—100 years ago—the empirical age ends!—L.A.E.)

THE EFFECT OF MILK YIELDS AND PASTURE VALUES ON THE COST OF BUTTERFAT PRODUCTION

By J. F. Byng-Hall, Soysambu, Elmenteita, Kenya Colony

Costs vary tremendously between district and district and even between adjoining farms. It was therefore decided that, for the purpose of a discussion such as is attempted in this article, costs must be based on as simple a system as is consistent with reasonably sound farming practice and one that is, broadly speaking, the foundation on which most farms are run to-day.

Briefly, then, the costs on this imaginary farm are calculated on the assumption that the natural pasture provides for maintenance and for the production of some milk, and that purchased concentrates are fed for production above this figure. Silage is grown for feeding during the dry season and to provide a reserve of fodder during drought or other bad years. Maize silage was selected as being the most commonly grown.

The cows calve the whole year round, not being restricted to any special season, and the birth-rate is 85 per cent per annum. The average number of cows in milk at any one time is two hundred; this is not too many to permit individual attention being given, and yet is sufficient to give a reasonable return. Each cow is assumed to milk for 274 days, so that 266 cows must calve during the year to maintain 200 in milk. This means, with an 85 per cent birth-rate, that the herd must consist of 313 cows.

It is assumed that the cows are milked on the movable bail system and allowance is made for the extra transport required.

As this article is concerned only with butterfat costs, just sufficient heifer cows are hand-reared to replace deaths and culls, and these calves are sired by bulls which might be expected to maintain the standard of the herd; the remainder of the cows being put in calf by any cheap bull. (This is not, of course, the usual practice, but the cost of breeding and raising calves in excess of those needed to maintain the herd cannot rightly be charged against butterfat.)

The farm is reckoned to be capable of carrying a beast to four acres, and the value of the grazing, in the first instance, is taken to be such that it will maintain a herd of cows in milk averaging 14 lb. of milk per head daily throughout the year, providing that silage is fed during the dry season and omitting drought or other bad years. During these bad years provision is made for the feeding of silage and extra concentrates to maintain the yield. (This figure of 14 lb. is taken as most of the writer's experience has been gained in a district where this is the probable value of the grazing. Later, figures are given for grazing worth 10 lb. and 20 lb. milk daily per head.)

Figures are given for four different yields:—

	Herd A	Herd B	Herd C	Herd D
	Lb.	*Lb.*	*Lb.*	*Lb.*
Average daily yield per cow in milk ..	10	15	20	25
Butterfat per annum per cow in herd	87·5	131·2	175	218·7
Total butterfat per annum	27,375	41,062	54,750	68,437

N.B.—Butterfat content of the milk is calculated at 3·75 per cent.

Further details are given under each item of expenditure below:—

Labour.—The cows are milked in two herds of 100 each. Each herd has a headman-clerk at Sh. 15 per month, who is responsible for the herd and recording; a separator boy at Sh. 12 per month; a calf boy at Sh. 10 per month. Herd A would require five milkers at Sh. 8 per month, Herd B six milkers, Herd C seven milkers, and Herd D eight milkers.

In addition it is necessary to have a herder for dry cows and another for heifers; a driver for a small cart to carry cream, feed, etc., and, say, three other assistants (bull boys, etc.).

With rations at Sh. 10 per 200 lb. bag the total cost of labour is:—

Herd A	Herd B	Herd C	Herd D
Sh. 3,552	Sh. 3,816	Sh. 4,080	Sh. 4,344

Bulls.—No attempt is made here to allow for any disease affecting breeding potentialities, and the minimum number of bulls only, using natural service, is estimated for; these bulls are also the lowest quality which, it is believed, would maintain, not raise, the standard of each herd. Fifty heifer calves should be reared each year to replace deaths or cows culled for non-breeding, udder troubles or age. Bulls are allowed three years' effective life.

Herd A.—Six grade bulls only should be required, and therefore two should be purchased yearly at £15: Sh. 600 per annum.

Herd B.—One pure-bred bull at £70 and two good grade bulls at £25, mated to selected cows, should produce 50 heifers of the required quality. The remainder of the cows could be bred to three other grades at £15. The replacement cost of these six bulls will amount to Sh. 1,166/66 per annum. In addition, the pure-bred bull will need 6 lb. daily of concentrates and the two good grades 3 lb. each, at 4 cents per lb. An additional bull boy will be required at Sh. 10 per month and rations, and a small amount required for buckets, halters, etc. The total cost will be Sh. 1,520 per annum.

Herd C.—On the same basis this herd will require three pure-bred bulls at £80 each and three cheap grades at £15. Extra feed will be needed for the pure-breds, and an extra bull boy. The total cost amounts to Sh. 2,440 per annum.

Herd D.—This herd will need three pure-bred bulls at £120 each and three cheap grades; other expenses as for Herd C. Total cost Sh. 3,240 per annum.

Calves.—Fifty heifer calves are to be reared. Each calf requires 42 gallons whole milk at 3.75 per cent butterfat equals 15.75 lb. butterfat at 80 cents, equals Sh. 12/60 per calf; two hundred lb. of feed at 5 cents equals Sh. 10 per calf; depreciation on buckets, etc., 40 cents per calf; a total of Sh. 23 per calf. The total cost for all herds is Sh. 1,150 per annum.

Feed.—The feeding system outlined above is that any butterfat produced in excess of that accounted for by the value of the grazing should be covered by a production ration of purchased concentrates, except in the dry season or in droughts and bad years, when silage is fed in addition.

Where pit silos can be made cheaply and where maize can be grown for silage at the rate of eight tons per acre, silage costs approximately Sh. 4/25 per ton. This figure includes cost of growing,

cutting, carting, chaffing, making and maintaining pit silos and depreciation.

The production ration, which is fed at the rate of 3½ lb. per gallon, is estimated to cost 4 cents per lb., and includes minerals.

Where the grazing is worth 14 lb. milk per cow daily throughout the year and 200 cows are in milk, the butterfat produced from this source is 38,325 lb. per annum.

Herd A.—Assuming that there were sufficient good cows to take advantage of the good seasons, this herd should not require any purchased concentrates. It would need 200 tons of silage per annum to provide dry season feed and a reserve to cover one drought year and one dry year in six: Sh. 850 per annum.

Herd B.—This herd produces 41,062 lb. of butterfat per annum. For four years in six it is estimated that the grazing will produce 38,325 lb. per annum; the fifth year is estimated to be a bad season and only 25,000 lb. will be produced by the grazing, while the sixth year will only account for 12,000 lb. (During these two latter years the production estimated as due to the grazing includes that due to feeding of silage reserves.)

From these figures it will be seen that it is necessary to feed for an average production of 9,345 lb. of butterfat per annum above that provided for by grazing and silage. The concentrates needed amount to 87,220 lb. and cost, at 4 cents, Sh. 3,488/80. In addition, 200 tons of silage are made, costing Sh. 850.

The total cost then is Sh. 4,338/80 per annum.

Herd C.—Calculated on the same basis as Herd B, it will be necessary to feed for 23,033 lb. of butterfat yearly, which costs Sh. 8,595/88. This herd will need more silage than the previous herds; say, 250 tons, costing Sh. 1,062/50.

The total cost then is Sh. 9,658/38 per annum.

Herd D, on the same basis, requires feed for 36,720 lb. of butterfat per annum, which costs Sh. 13,703/80. An increase in silage is advisable; say, to 300 tons made yearly, and costing Sh. 1,275, making a total cost of Sh. 14,978/80 per annum.

Dip.—Dipping fluid and depreciation, all herds the same: Sh. 360 per annum.

Vaccines and Medicines.—The cost of inoculating all stock with one inoculation of rinderpest vaccine and giving 50 heifers a year a full course of three inoculations amounts to Sh. 185. In addition, 50 calves should be vaccinated for blackleg. The balance covers extra vaccines, medicines, salves, etc. All herds the same: Sh. 500 per annum.

Repairs.—All repairs to bails, wagons, carts, implements, fences, etc., including materials and labour costs. All herds: Sh. 1,000 per annum.

Renewals and Depreciation on all implements, separators, loose plant, etc., not covered by other accounts. All herds: Sh. 750 per annum.

Sundries.—Paraffin, separator oil, cotton-wool filters, stationery, postages, etc.: Sh. 500 per annum.

Extra Transport.—Moving of bails, carting silage and concentrates; labour and rations only: Herd A, Sh. 195 per annum; Herd B, Sh. 216; Herd C, Sh. 270; Herd D, Sh. 346 per annum.

Land Office Rent.—2,000 acres at 20 cents per annum, all herds: Sh. 400 per annum.

COSTS PER ANNUM (IN SHILLINGS) WHEN GRAZING IS VALUED AT 14 LB. MILK PER COW DAILY

	Herd A	Herd B	Herd C	Herd D
	Sh. cts.	*Sh. cts.*	*Sh. cts.*	*Sh. cts.*
Labour	3,552 00	3,816 00	4,080 00	4,344 00
Bulls	600 00	1,520 00	2,440 00	3,240 00
Calves	1,150 00	1,150 00	1,150 00	1,150 00
Feed	850 00	4,338 80	9,658 38	14,978 80
Dip	360 00	360 00	360 00	360 00
Vaccines and medicines	500 00	500 00	500 00	500 00
Repairs	1,000 00	1,000 00	1,000 00	1,000 00
Renewals and depreciation	750 00	750 00	750 00	750 00
Sundries	500 00	500 00	500 00	500 00
Extra transport	195 00	216 00	270 00	346 00
Land Office rent	400 00	400 00	400 00	400 00
Total Costs	9,857 00	14,550 80	21,108 38	27,568 80

COST IN CENTS PER LB. BUTTERFAT WHEN GRAZING IS VALUED AT 14 LB. MILK PER COW PER DAY

	Herd A	Herd B	Herd C	Herd D
Labour	12·9	9·3	7·5	6·3
Bulls	2·2	3·7	4·4	4·7
Calves	4·2	2·8	2·1	1·7
Feed	3·1	10·6	17·6	21·8
Dip	1·3	0·9	0·7	0·5
Vaccines and medicines	1·9	1·2	0·9	0·7
Repairs	3·8	2·4	1·8	1·4
Renewals and depreciation	2·8	1·8	1·3	1·1
Sundries	1·9	1·2	0·9	0·7
Land Office rent	1·4	1·0	0·7	0·6
Extra transport	0·7	0·5	0·5	0·5
Total Costs	36·2	35·4	38·4	40·0

PROFITS (IN SHILLINGS) MADE BY EACH HERD

	Herd A	Herd B	Herd C	Herd D
	Sh. cts.	*Sh. cts.*	*Sh. cts.*	*Sh. cts.*
*REVENUE—Butterfat at 80 cents per lb.	21,900 00	32,849 00	43,800 00	54,749 60
EXPENDITURE—As above	9,357 00	14,550 80	21,108 38	27,568 80
PROFIT PER ANNUM *Sh.*	12,043 00	18,298 20	22,691 62	27,180 80

*For simplicity no allowance has been made for the value of skim milk available for pig feeding, etc., or for culled cows sold.

The figures show clearly that, in Kenya as in other countries, it is more profitable to milk good cows than bad ones.

It is interesting to note, however, that the cost per lb. increases with the higher yields. This is due to the great increase in purchased concentrates needed to bridge the gap between the value of the grazing and the amount the cows produce.

It would seem to show that it is not sound practice to try and milk high-yielding cows on poor pasture unless the production ration can be bought or grown at considerably less than the figure given.

Difficulties crop up when the cost of home-grown concentrates is investigated. It is unlikely that it would be possible to produce home-grown protein-rich concentrates cheaper than they can be bought while simsim and groundnut cakes are at the prices that have ruled for some years. With the starchy foods the position is somewhat different; but here again, unless the farm be situated in a maize-growing area or is an adjunct to a cereal-growing farm, no very great savings can be anticipated. A point not to be overlooked when estimating the cost of a home-grown concentrate compared with that of a purchased one is the manurial value brought on to the farm when concentrates are bought.

Apart from concentrates, however, it is possible, except in the case of very high-yielding cows, to make up a large part of the food necessary by high-value roughages such as lucerne, lucerne hay, cowpea hay, etc. Grass silage would seem to offer great possibilities in this direction.

Such a method of farming is obviously a considerable advance on that on which the figures are based, and is likely to give better results as, in all probability, during the short dry spells which occur throughout even the best year the cows would not get sufficient succulence from the grazing to enable them to make full use of their production ration, as their only food would be drying pasture and concentrates.

Another method of reducing the feed bill is to increase the value of the pasture.

The following figures give the result on feed cost, and on the total cost, of running the cows on pasture worth respectively 10 lb., 14 lb. and 20 lb. milk per cow per day.

On the 10 lb. grazing it is assumed that during a drought year the grazing will only produce 8,000 lb. of butterfat for 200 cows in milk, and 15,000 lb. in a dry year; while on the 20 lb. grazing the same figures are 25,000 lb. and 35,000 lb. Otherwise costs are calculated as before.

THE EFFECT OF GRAZING VALUES ON COST OF BUTTERFAT (Figures being cents per lb.)

	Herd A	Herd B	Herd C	Herd D
Grazing value 10 lb. milk per cow per day:				
Feed cost ..	10·3	19·3	24·2	27·1
Total cost ..	43·4	44·1	45·0	45·3
Grazing value 14 lb. milk per cow per day:				
Feed cost ..	3·1	10·6	17·6	21·8
Total cost ..	36·2	35·4	38·4	40·0
Grazing value 20 lb. milk per cow per day:				
Feed cost ..	—	2·1	7·5	13·8
Total cost ..	—	26·9	28·3	32·0

The figures illustrate clearly the close relation between the value of the grazing and the cost of production. In each case the lowest running costs are found in herds in which the yield approximates nearly to that of the value of the grazing. In Herd C the saving in costs on the 20 lb. grazing over the 14 lb. grazing amounts to 11.1 cents per lb., which means a

saving of nearly £300 a year. The amount represents interest on a large capital sum and gives some idea of what can profitably be spent on improving pasture, or of what extra value good pasture has. It should be noted that the yields in the highest herd, Herd D, are not quite as good as the *average* herd in New Zealand, where pasture improvement is carried to a high level.

A tremendous lot of work remains to be done in investigating the improvement of pastures in this country. It is, however, possible to make better use of the present standard of pasture by making the cows calve at the most suitable time of year.

The writer examined nearly 1,000 records of cows, run on somewhat similar lines to those on which these figures are based and which gave in yields something between Herds B and C, on grazing which would seem to be of the value of about 14 lb. per cow per day throughout the year. Silage was fed during the dry season, which lasts from January to the end of March. It was found that the best months for cows to calve (taken over a number of years, including dry ones) were May and June. Giving these two months the value of 100, the results were as follows:

Cows calving during:	
January and February gave ..	77·5
March and April gave	86·0
May and June gave	100·0
July and August gave	99·6
September and October gave ..	90·9
November and December gave ..	86·9

In Herd C, assuming that the cows calved in equal numbers during each two-monthly period throughout the year, the 266 cows that calved gave 206 lb. butterfat on an average on 14 lb. grazing.

Those calving in:	On the figures given above
Jan. and Feb. would have given	177 lb.
March and April would have given	196 lb.
May and June would have given	229 lb.
July and Aug. would have given	228 lb.
Sept. and Oct. would have given	208 lb.
Nov. and Dec. would have given	198 lb.

Had all 266 cows calved during May and June, therefore, they would have produced 60,914 lb. of butterfat for the same amount of feed, instead of 54,750 lb., an increase of 6,164 lb. per annum with no extra cost. This reduces the cost of production to 34.6 cents per lb., and increases the profit by Sh. 4,931 to Sh. 27,622/62.

For Herd D, the figures are an increase of 7,585 lb. per annum, which reduces the costs to 36.2 per lb. and increases the profit by Sh. 6,068 to Sh. 33,248.

There are several advantages in this method. It permits of better use of artificial insemination when all cows are to be served during a short period, and supervision would be simplified during the most important period, i.e. before and after calving and during the early days of the calf's life. It would allow the farmer to do all repair work and building work during the off season and to take a holiday with easy mind. It would not be necessary to feed silage during the dry season and so a very large reserve could be accumulated for drought years, and would probably keep the cows in better condition throughout the year.

There are disadvantages. In a drought year the cows would be calving at what would probably be the worst period, but to off-set this there would be large reserves of feed. Calves would be weaned at the beginning of the dry season, but this should not present insuperable difficulties. Another possible difficulty is that this season is not the natural time for cows to calve in this country.

In conclusion, the writer is aware of many shortcomings in the method of setting out these figures and offers them with diffidence. Although the figures are based on experience, the nature of the article necessitates a considerable amount of inference.

SOME NOTES ON EAST AFRICAN SHEEP FARMING

By W. E. Powys, Kisima, Timau, Kenya Colony

This article does not pretend to describe the orthodox points of the merino, or any other sheep farmed in this country; such information can better be obtained from any textbook. The matter of it is to be that which you will not find in most sheep books, as it applies mainly to conditions only obtaining in Kenya.

The sheep native to this country carries no wool at all, and the flockmaster must be careful not to pile wool on to a frame at the expense of the constitution. The type of merino I have found to thrive best and give the lowest death-rate still show considerable characteristics of the native sheep though they will clip up to eight pounds per annum of fine wool. Good open faces and well up on their legs, plain bodies and big frames, sheep which look capable of getting around rough country to pick up their living in the very short time allowed during the day and of walking some miles to water, will live longest.

Those who are starting sheep farming in East Africa and have never had the opportunity of studying the ways of sheep—their likes and dislikes, their diseases, their wool and how best to class this for sale—should arm themselves with a guide book or two for reference. There are a number of publications on the subject, the most useful for the country we live in being *Sheep Farm and Station Management*, published by the Pastoral Review Pty. Ltd., Melbourne, Australia, and, for reference at shearing time, *The Sheep and Wool Industry of Australia* (Whitecombe and Toms, Melbourne).

We look forward to the publication by the Veterinary Department of Kenya of an up-to-date edition of their valuable *Aids to Stockowners*,[1] which will describe the many new methods of dealing with local sheep troubles that have been discovered by the Research Laboratory during the last few years.

In order to keep them safe from hyenas, lions, leopards and wild dogs it is necessary to fold sheep at night. This entails very hard conditions. It means that for twelve, thirteen, fourteen or, if the owner is not very lively in the early morning, possibly fifteen hours out of every twenty-four, the sheep are penned up in a confined space, unable to feed or water. Until we have killed off all the vermin and have paddocks where they can remain, unherded, night and day, good herding is of the utmost importance in order that the sheep shall get the maximum of unmolested quiet grazing. To ensure this do not *boma* two flocks at the same camp, for then the herds dare not let the flocks out till they have fed themselves for fear of mixing them. In the case of one flock alone the sheep can be out well before sunrise and feeding while the herd has breakfast.

Most natives like herding, and a good herd is invaluable. He should be very quiet, very watchful—if possible, a vegetarian—letting his sheep out before sunrise and returning with them to the *boma* after sundown; silently guiding them to the best pasture, grazing all the way to water and all the way from water. We do not want the kind of man who loves to go after his sheep with a handful of long sticks and a tin of pebbles to rattle and throw at the hindmost, forever whistling and shouting, taking his sheep to water the last mile in a troop and a cloud of dust, hustling them along as hard as he can get them to go. Mutton fat oozes and drips from his face; you can smell him within yards and hear him within miles. Be sure and avoid that kind of gentleman.

[1] This is now being published in this Journal under the title of "Notes on Animal Diseases."

To make a good herd you must inspire him with as great an interest in his sheep as you have yourself. So unless you have untiring interest in them yourself leave them alone—go in for cattle or crops. A herd to be interested in his flock wants more from you than a weekly visit when you come along and say: "*Kondoo mzuri?*" "*Ndio, Bwana.*" "*Mzuri sana*; let's go back to breakfast."

Bide a minute. Don't be in such a hurry about your breakfast. Look through that flock and see if you can spot anything wrong there. A sheep scratching, maybe flyblown or has scab or keds; keep a good look out for any sheep showing the first signs of wireworm infection, back humped up or scouring. Look through the dung left in the *boma* to see if there are any segments of tapeworm.

"Be thou diligent to know the state of thy flocks and look well to thy herds." This sound piece of advice comes from the Book of Proverbs. Do not trust the herd—however excellent his work—to let you know of the beginning of any sickness.

[1]*Bomas* are best constructed of sheep netting, four feet high; two hundred yards of netting for a thousand sheep gives them plenty of room. On dusty country the wire should be moved every day. Some flockmasters prefer permanent leopard-proof paddocks to run the sheep in at night, but these are expensive to construct, and unless you build a great number all over your farm the sheep are liable to be kept on the same ground too long at a time. A few rolls of wire-netting, a bundle of sticks and a portable tin hut can be moved anywhere on a small wagon.

Any death should be reported by the *boma* boy at once, and the skin brought in. I make a strict rule that no carcass is to be opened until this has been done and I have thus had the opportunity of investigating the cause of death myself. It is not always possible to go out and conduct a post-mortem, but whether the dead sheep is opened up by the owner or by the *boma* boy, another good rule is that all the fat be invariably brought in, otherwise a regular trade in sheep fat will sooner or later ensue between your farm and the local native reserve.

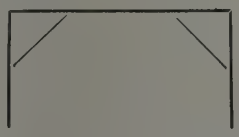
The fat from dead sheep, when rendered down, is a very useful commodity on the farm for softening riems and greasing the heavy boots. Mixed with caustic soda, it makes excellent household soap, but the excellence of the soap depends on the skill of the hands which make it. I was asked politely some years ago by a guest in my house if I could explain why it was that the clean towels always smelt of dead sheep!

A good system of keeping the counts is important. Keep a list of the flocks and the numbers in each one in your pocket-book. All deaths and transfers should be marked up daily. At the end of each month every sheep should be counted and a return made out and entered in the sheep book. It is a useful guide to the state of the health of the flock to work out the death-rate at the end of each month on a twelve months' basis.

When planning yards for handling the sheep, whether permanent round the dip, or temporary pens of hurdles or wire for dosing or drafting at the *bomas*, always remember that sheep can be easily driven up a slope; they have a natural tendency to go up hill. Much trouble to yourself and the flock will be saved if the receiving yard is on a slightly lower level than the forcing pen, and this again slopes gently up to the drafting race, dosing pens or the dip. Badly constructed yards are

[1] *Boma*=enclosure or pen.

usually the reason for this not unfamiliar scene: Sheep going in every direction but the right one; boys shouting and whistling, their arms working like flails; the owner cursing and swearing, till, patience exhausted and tempers frayed, the sheep are caught one by one and dragged, usually by the forelegs or the ears, to the desired spot. With the yards sloping the right way, provided there is no noise, one man moving slowly through the flock, coming *from* the direction in which you wish them to go, will start them moving, and once the leader has started the rest follow. When the yards are in use day after day they should be regularly swept and, if possible, watered. Sheep cannot be worked easily in a cloud of dust, and a large proportion of the dust raised is bound to penetrate the wool. To fetch a good price, the wool must be clean. Sheep love to crowd in corners, and it is a help to have corners fenced off thus—



If the yards are so constructed that sheep will not run well you will save endless time and worry if you pull them up and build them again. Dosing, dipping, foot-rotting, or any handling of sheep should be done as early as possible—as soon as there is enough daylight to see; the earlier you start the sooner they get out to graze.

The same rule applies at shearing time. Remember to give the sheep the maximum length of time for grazing. Do not keep them waiting about, nor the shearers waiting for the sheep. Do not make the counting-out pens too big, and count out as often as possible. Sweating pens should not be built to hold more than fifty sheep each, or some are sure to get smothered.

If sheep are housed at night, see that the house is absolutely leopard-proof. A leopard will jump into a wire *boma* or over rails, take a sheep and go off with it; but should he make his way into a building where there are sheep, finding himself in a confined space he will most certainly run amok and kill every one. This has happened more than once in the history of Kenya sheep-farming.

The moment an outbreak of scab is discovered it must be dealt with immediately. Should there be more than four months' wool on the sheep the owner will be well advised to shear and then dip at once. Satisfactory results cannot be obtained by dipping with more than four months' wool on; the solution will very likely not penetrate to the affected part, and it is much harder on the sheep than being dipped with no great weight of fleece to absorb the arsenic. Approximately a gallon of solution will be taken out per sheep as against a quarter of a gallon when dipped off shears. It will pay you in the long run to sacrifice the wool and cure the scab. Follow minutely the manufacturer's directions regarding the mixing of whatever brand of dip you may use. Far too many casualties occur due to faulty mixing.

Pick out all sheep showing scab before they enter the dipping bath and scrub the infected places with warm water and soap. Do not dip too many sheep at a time; five hundred a day for the first dipping, with two minutes' immersion, is quite sufficient. If the dipping continues for hours, the boys get tired and the work is not thoroughly carried out; some sheep will slip through too quickly, others will not be properly submerged; the sheep may get blocked in the dip, so that some stay in too long and are poisoned. It needs constant and unremitting attention on the part of every man taking part.

Dipping should always end before noon in order to give the sheep time to get thoroughly dry before nightfall.

Owners of big flocks and only one dip are faced with the difficulty of getting everything dipped the first time before the second immersion is due at the regulation interval of eight days. Experience has shown that the best way to eradicate scab is to concentrate on thoroughness at the first dipping. Carefully timed two-minute immersion, preceded by hand dressing of any badly infected cases, will give better results than rushing large numbers of sheep through the dip in order to do the same thing eight days later.

If the second dipping takes place fourteen or more days after the first, full strength solution may be used and the sheep given one minute's immersion. Thus double the number of sheep can be put through the bath in one morning, and the third dipping should easily be accomplished eight days later. In badly infected flocks, yet a fourth dipping is advised fourteen days after the third.

Dealing with ewes and small lambs entails considerable difficulties. Should an outbreak occur while lambs are running with the ewes it must be dealt with, as even the youngest can easily become infected, but this is done at grave risk to the lambs. Young lambs swim like trout, and are very difficult to control in the dip. They plunge about, climb on the backs of their fellows, half drowning them, and bleat for their mothers so that they swallow quantities of dip. There are approximately three months in each year when dipping can be carried out so thoroughly as to ensure every chance of scab being finally eradicated from the flock; after weaning and before the ewes are heavy in lamb again this opportunity presents itself. Shearing should be done, if possible, at the beginning of the dry season. An adequate period of dry weather can then be reasonably expected for dipping the sheep off shears.

The tupping season will vary considerably in Kenya. It must be arranged so that the first lambs will be dropped about a week after the best rains of the year are expected. In some parts of the country this will be from April to June; others from October to December. Some say, "More rams, more lambs," but in my experience the best results have been obtained by putting not more than two per cent of rams into the ewes at a time, another two per cent in reserve, and the rams changed every day or every other day. By this method the risk of sore pizzles is reduced to a minimum. This disease is aggravated by one ewe being served by two or more rams in succession. If not more than two per cent of rams are running with the ewes it is unlikely that any will be served more than once.

During tupping the rams should be turned and carefully examined every few days. Any indication of bleeding or soreness must be treated with iodoform powder or a solution of permanganate of potash and the ram kept out of the ewes until the affected part is completely healed. Rams are usually run with the ewes for a period of six to seven weeks.

Very valuable experimental work has been done at the Naivasha Government Farm on artificial insemination, and successful results have been obtained by private flockmasters. This will doubtless be the quickest and most economical method of improving our flocks in the future. A full account of how this work should be carried out is published in Volume III, No. 2, of the *East African Agricultural Journal.*

The less the ewes are yarded during pregnancy the better; dosing, dipping or trimming of feet should not be done after

the first two months have expired. During the later months it is important that the quietest and best herds should be in charge, and those who can count the sheep through a wide gateway. Just before lambing the ewes should be split into flocks not exceeding five or six hundred; these are again reduced by half as the ewes lamb. Maiden ewes are often apt to be troublesome over taking their lambs; it is a great help to the herds if they are divided up amongst older ewe flocks.

Immediately it is dropped, every lamb's navel string should be painted with iodine as a precaution against joint evil. A golden rule throughout lambing is to move the wire *boma* continually on to fresh ground. This is especially important before tailing.

Tailing, castrating and ear-marking may be begun when the first lambs are three to four weeks old. To minimize bleeding this is best done very early in the morning, when it is cool, and before the lambs have moved about.

For tailing some recommend the burdizzos, others a hot iron, but to ensure quick healing the writer prefers a sharp knife.

See that the ewes are taken to water the day before you intend to tail, so that after the operation the flock need not be driven anywhere and the lambs can lie about as they wish.

At the higher altitudes, in cold or wet weather, the ewes will be very prone to suffer from garget. The first symptoms will be stiffness of the hind legs and spasmodic feeding. Prompt measures are necessary if the udder, or even the life of the ewe is to be saved. The affected quarter must be milked out and hot fomentations applied. Massage with castor oil may help, and a thick dressing of Stockholm tar should be applied after every treatment.

Lambs which have not been castrated and are kept for rams must be carefully watched and weaned as soon as they show signs of taking any interest in the ewes. In a good season, when the lambs thrive, this may occur at any time after they are four months old.

The remainder of the lambs can be weaned at between five and six months, according to the state of the grass. They should always be weaned on to green grass if possible, and dosed for intestinal parasites before being despatched to their new pastures.

Within a week or so of weaning, the ewes should be brought in and any with distended udders milked out.

According to the carrying capacity of your farm, you will now cull out all ewes of a certain age and those which do not come up to your required standard of wool. Ewes with deformed mouths or devil's grips will never be profitable animals. They should go to the butcher, together with the obvious barreners and those with damaged udders due to garget or injury. It is a mistake to send a ewe to ram unless she can rear a good lamb.

The beginner will have many disappointments. I beg him not to be discouraged by the holocausts and calamities that may fall on his flocks. Sheep all over the world have a habit of dying in numbers at times. An evil spirit descends on them in the form of disease, drought, fire, water; or a hyena, on a dark night, may tear to pieces a score or more; wool prices may drop suddenly and drastically, and, as suddenly, rise again. Sheep have a remarkable capacity for recovery and for making a quick increase. Just when you think you have lost all, with the help of one good season you will again find yourself the owner of a fine flock and a good wool cheque.

CARCASS DEVELOPMENT OF LIVE STOCK IN TANGANYIKA TERRITORY

(A REVIEW OF FIVE PAPERS* BY DR. M. H. FRENCH)

By H. J. Lowe, Director of Veterinary Services and Animal Husbandry, Mpwapwa, Tanganyika Territory

Papers I, IV and V deal with cattle and may be taken together. In comparison with English cattle the Tanganyika zebu comes out of this examination rather badly.

Dr. French states that "The average zebu ox is less than half the weight of the average British steer." The internal and external deposits of fat are much greater in the European breeds; the fat of the zebu is most often yellowish in colour, the meat is often dark as a result of long walks in search of grazing, and altogether the carcass is unsuited for British markets. The author suggests that these Tanganyika zebu cattle are more fitted for a canning and extracting industry, or for conversion into fertilizers or animal feeding stuffs. They might also be useful for the preparation of biological medicaments.

The indigenous animals of Tanganyika Territory seem to have lost the ability—if they ever possessed it—to deposit fat *within* their musculature. They can, of course, produce a carcass with abundant fat in the subcutaneous and intermuscular spaces, but the deposition of adipose tissue between the muscle fibres, so as to give that streaky appearance of high quality meat, is seldom if ever observed in the native cattle or sheep of Tanganyika. It is hard to say whether this is due to a genetical factor or to the environment.

During the wet season, which may last four months, grazing is plentiful and cattle put on weight, but this increase in weight is to a large extent lost by the end of the dry season. This circumstance, plus the long distances they usually have to trek to markets, militates against the production of fat stock. One of the duties of the Department of Animal Husbandry is to try to ameliorate these conditions, so that as far as possible sufficient pasture or feed shall be available throughout the year. For this purpose—and at the same time to reduce accelerated soil erosion—a system of rotational grazing has been instituted by Staples in certain parts of the densely stocked areas. With the co-operation of the provincial administration the system has so far proved markedly successful.

The cattle examined by Dr. French were derived almost entirely from the Central Province of Tanganyika. On the average these would compare unfavourably with cattle from the Bara Baig

* I. "Actual and Proportional Weights of the Various Parts of the Body of Zebu Cattle," *Emp. J. Exp. Agric.*, IV, 13, January, 1936.

II. "Tanganyika Breeds of Sheep, and Mutton Qualities of the Long-tailed Type and its Crosses with Black-headed Persian Sheep," *Emp. J. Exp. Agric.*, VI, 22, April, 1938.

III. "Skeletal Measurements of Local Fat-tailed and Grade Black-headed Persian Sheep," *Emp. J. Exp. Agric.*, VI, 23, July, 1938.

IV. "The Liveweight Development of Certain Short-horned Zebu Cattle in Tanganyika Territory," *Tropical Agriculture*, XVI, 3, March, 1939.

V. "The Weights of the Carcass and of the Individual Organs in the Body of Cattle in Kenya Colony," *Emp. J. Exp. Agric.*, IV, 14, April, 1936.

country of the Southern Mbulu district, or with Masai stock, but they are better than the cattle from any of the overstocked areas.

Of 313 carcasses examined the average carcass weight of adult animals was 260 lb. Ten of the biggest averaged 381 lb., and these showed a larger ratio of meat and fat to offal—which is what the traders want.

In regard to prices, Dr. French states: "1 lb. of carcass costs ¾d., and nowhere in the world, so far as I can ascertain, does meat cost less." Prices in 1936 must not be accepted as applicable to every year. It is well known that prices of slaughter stock fluctuate tremendously. For instance, in a year in which rainfall has been good and the monetary return from cash crops such as cotton and groundnuts has been sufficient for the needs of the people, the sales of cattle fall and hence prices rise, but in years when rains have failed and the people are forced to market their cattle to obtain money, prices decline. It is therefore a point for consideration whether in the general economics of the Territory it would not be wiser, in certain overstocked areas, to discourage increased production of cash crops and so encourage the people to sell their cattle. Messrs. Liebig's, Ltd., Kenya, would, it is felt, be only too glad to provide an outlet for such stock as are surplus to our territorial requirements. Increased production of cash crops in many of the native areas of East Africa still means increased acreage under cultivation, with a corresponding reduction in available pasture and a consequent intensifying of the overstocking and soil erosion problem.

In paper IV, Dr. French summarizes his results as follows:—

(1) Owing to seasonal rainfall, short periods of good grazing alternate with long intervals of drought. As a result the liveweight curve of zebu cattle follows an undulating course.

(2) The shape of the growth curve can be correlated with the variations in the feeding value of the grazing.

(3) Under good native conditions the zebus grow well during their first three rainy seasons but their weight becomes stabilized around 650–700 lb. at seven years old.

(4) Given good feeding conditions, a very much accelerated rate of growth is attained. The stunting of innumerable generations by our hard conditions has not destroyed the capacity for greater growth rates than are usually exhibited.

The Editor of *Tropical Agriculture*, in a headnote, points out that the conclusions are based on the average weights of only four head of cattle, and hence are of limited value. This is quite true, but unfortunately the funds and facilities at disposal for this work in Tanganyika are extremely limited, and under these circumstances it is preferable to have accurate data from small numbers in an experiment than less reliable figures from larger numbers.

In paper V, the author shows that the Kenya native zebu is on the average a somewhat heavier beast than his prototype in Tanganyika. It is surprising to learn that the Kenya zebu green hide is over 10 lb. heavier than that of the Tanganyika zebu. This of itself would account for the markedly higher value of hides sold annually in Kenya. This heavier weight of the Kenya hide would appear to be due to a greater thickness of the skin itself and not to the difference in the size of the animals.

The grading up of cattle on European farms in Kenya has resulted in a much improved carcass which is suitable for

export, but this improvement could be still further enhanced by the introduction of a good light-boned breed such as the Aberdeen Angus.

In papers II and III the subject is the mutton qualities of Tanganyika sheep. The local indigenous sheep are of poor quality, but they are not improved by crossing with the Black-headed Persian. "Judged by the muscle-fat-bone ratio, the Persian has produced a carcass inferior to that of the pure Tanganyika breed."

These five papers form a very valuable contribution to our knowledge of the potentialities of Tanganyika cattle and sheep for meat and mutton production, and the author is to be congratulated on a masterly piece of research on an animal husbandry problem which heretofore has not received the attention it deserves.

KENYA FARMERS PROGNOSTICATED?

"The character of the farmers admits of much diversity. A few, from being shepherds, have risen with a fair character to rent farms of considerable extent, and retain the simple and homely manners, dress, and fare of their primeval occupation. But by far the most numerous class are sons of farmers, either in this or neighbouring counties; among whom, according to the difference of their natural talents and tempers, of their opportunities to mix with good company and receive information, and of their early habits, there appears much characteristic variety in point of behaviour, living, and managing their farms. Some of them are wonderfully tenacious of ancient practices; but their number is now much reduced. Others venture on innovations with slow and timid steps, but grow bolder by the experience of their own or their near neighbour's success. And several carry on improvements with a degree of spirit and skill, which is not easily surpassed, and which has abundantly repaid their trouble and risk. In general, they all deserve the praise of being frank, communicative, and hospitable. Their tables are much better provided, than the appearance of their houses affords any reason to expect; and there are, in their looks and manner, a cordial welcome, and an urgency to partake of their meat and drink, which strongly indicate a kind heart. A few of them live in elegance and plenty, have a plain dinner well dressed and served every day, and a bottle of wine or a cheerful glass of punch for a friend. But none of them keeps a chaise, or a man-servant for any household purposes. Being all trained up from their infancy to ride, they themselves, their wives, and their children can manage a horse with some dexterity; and can climb steep mountains, either on horseback, or on foot, without much inconveniency. They are very sociable, and even the most recluse are loth to part, especially when they meet together at markets and fairs; but, of late, there have been few or no instances of their neglecting necessary business for the sake of their bottle, or companions, or indeed for any other enjoyment. Attempts to deceive and over-reach purchasers, though not wholly unknown among some of them, are held in utter contempt by the better sort; and, upon the whole, they are very punctual in fulfilling bargains, and making payments. Their chief defect is a degree of indifference for that kind of knowledge, which can only be acquired from books, or from more frequent and enlarged intercourse with mankind."

—*General View of the Agriculture in the County of Selkirk*, 1798.

NATIVE METHODS OF FOOD STORAGE

The following notes on native methods of storing foodstuffs have been contributed by Agricultural Officers in Kenya. It is hoped that descriptions parallel to these, or discussions of wider aspects of the same general subject, will be forthcoming from other districts, so that the series may be continued and in time form a fairly complete record of these interesting practices.—ED.

I—IN THE EMBU DISTRICT OF KENYA

By P. C. Chambers, B.A., Dip. Agric. (Cantab.)

There are four divisions in this district: Ndia and Kichugu to the west, both peopled by the Kikuyu tribe, and Embe and Mbere to the east, each with its own tribe. The methods adopted vary from tribe to tribe, and are best classified according to foodstuff.

Maize.—In Ndia and Kichugu maize is stored on the cob in small round stores similar in appearance to the dwelling-huts but with the floor usually raised some two feet from the ground. In the past the sheaths were not usually removed from the cobs, but this practice is now becoming more general. At the eastern end of Kichugu the cobs are sometimes tied to poles in the open. In the Embu division the common practice is to hang the sheathed cobs in trees, tightly covering the branches and the trunk to within a few feet from the ground. The cobs are removed as required, starting from the top. In Mbere, where little maize is grown, the Embu custom has been adopted, but as failure of this crop is frequent a few cobs for seed are always hung in the roofs of huts, where smoke prevents insect damage.

Millets.—Bulrush is the only millet grown to any extent in the district, and the methods refer to this species. In all the divisions the grain after threshing is stored in *miruru,* which are flask-shaped stores made of wickerwork, with the mouth on top some two feet in diameter. In Ndia and Kichugu they are much larger than in Mbere; many could hold three people. These *miruru* are set up on poles about two feet from the ground and a roof is built over them.

The difference between the practice in Mbere and in the other three divisions is in the amount of plastering done to the *miruru.* In Mbere they are re-plastered with mud or cow-dung inside and out every year, to keep out insects, and after the removal of a week's supply the lid, usually a winnowing tray, is carefully sealed on again with plaster. In the other divisions insects are not considered important, and the *miruru* are plastered on the inside only and re-plastered as required; in Ndia and Kichugu the mouths are either covered with a tray or earthenware vessel or sewn up with fibre. In Embu the lids are plastered and sealed after each removal.

Millet for seed is stored separately. In Mbere it is kept in large gourds or earthenware vessels with a layer of ash on top, and the mouth is sealed. In the other divisions the seed is similarly stored but no ash is used and the mouths are not usually sealed.

In Ndia and Kichugu any excess, and sometimes the whole crop, of millet is stored in beehives.

Sorghum.—Little sorghum is grown except in Mbere, where it is used both for food and the making of liquor. After threshing, when thoroughly dry, the grain is stored in *ngitu,* which are similar in appearance to *miruru,* but are made of

grass instead of withies and are only used for one crop, new ones being made each season. These *ngitu* are plastered inside and out and sealed in the same way as the *miruru*. The reason for the difference is apparently that sorghums are more liable to insect damage, and therefore new storage vessels are necessary each season.

Sorghum for seed is kept in pots after mixing with ashes, and a layer of ashes and sand is laid on top. The object of the sand is stated to be the prevention of theft by children, who are very partial to eating raw sorghum. Any disturbance causes the sand to mix with the seed and thus it deters theft.

Legumes.—In Embu, Ndia and Kichugu, legumes, mainly Boston and Rose Coco beans, njahi (*Dolichos lablab*) and cowpeas, are threshed on harvesting and kept in pots or bags in stores as described above under maize. Occasionally empty *miruru* are utilized.

In Mbere cowpeas and green gram, the main legume crops, are stored in the pod loose in stores and are shelled as required. For seed the legumes are threshed and stored in pots or gourds without winnowing; the fragments of pod are left to show that they are for seed purposes. As for the other seeds, it is usual to put a layer of ash on top and to seal the lid.

Cassava.—Cassava is generally lifted as required, but in Mbere, when plentiful, it is sometimes peeled and split and left on the roofs of stores and huts to dry in the sun.

II—IN THE COAST PROVINCE OF KENYA

By the Agricultural Officer in Charge

The usual method of storing food at the coast is in the hut. The native hut is generally divided into two parts, the one forming the living accommodation and the other the kitchen and store.

In this second section a framework is built across, making the upper part a kind of loft. This is plastered with mud, except for an aperture facing the living room, and it provides a large store for maize. The maize is generally left in the cob and the store then filled.

Below this store is the kitchen in which a fire is generally burning, the smoke from which permeates the store above. In this way the maize is subjected to continued smoke without scorching and the grain keeps remarkably well and free from weevil infestation.

III—BY THE MERU TRIBE IN KENYA

By J. T. Moon

Before mentioning the actual methods of food storage used for the various crops a description of the stores, vessels and articles employed is given under their several native names.

Nchuku.—A round building used for the temporary storage of food crops prior to threshing. The floor is raised about three feet off the ground and is constructed of thin sticks, the spaces being filled with cow-dung. The building is on the average about six feet in diameter and four feet from the floor to the eaves. The doorway is closed by placing roughly hewn native planks on top of one another edge to edge.

Muru.—A large, gourd-shaped structure with a neck just wide enough for an arm to be inserted. The diameter of the base may be up to three feet. The framework is constructed of slender sticks and is covered with long grass tied in narrow bundles about two inches in diameter, the outside being coated with cow-dung. The *muru* is sometimes left outside the house, in which case a roughly thatched roof is constructed over it. More often it is to be

found in the actual living quarters; but in both cases it is placed on a small platform.

MERU GRAIN STORE
[Native name : *Muru*]

The capacity of a *muru* may be up to 600 lb. When nearly full food is withdrawn by hand when required, but as the level drops it is necessary to tilt it over to pour out the grain. A certain amount of heat is produced, but the grain may keep for a year. Infestation with grain moths is sometimes serious.

Githu.—An article composed entirely of grass and native fibre. It is constructed by placing on the ground lengths of long grass under which parallel lengths of native fibres have been previously laid at close intervals in a direction crosswise to that of the grass. The grain to be stored is heaped on the grass, and meanwhile the sides of the vessel are built up and gathered in. As construction proceeds further grain is poured in from time to time.

While the structure is, as it were, being built around the grain, the vessel is lying on its side—the points where the ends of the grasses forming the opposing sides meet will eventually be the top and bottom of the *githu.* On completion it is practically spherical in shape with a slightly flattened bottom.

As the *githu* is generally left in the open the top is finished with a tightly bound twist of the grass ends, like that at the apex of a thatched roof on some native huts. The parallel lengths of fibre are finally criss-crossed with further fibre to hold them in place.

Although it is difficult to believe, the *githu* is reputed to be quite weatherproof. Its capacity may be 100 lb. or more.

Nyungu.—An earthenware pot used for storing seed; it is plugged with a gourd or banana bark and sealed with cow-dung. The *githiri* is similar to the *nyungu,* but has a narrower neck.

Methods Adopted for Various Crops

Bulrush Millet.—The crop is stored on the ear for one or two months in the *nchuku.* After threshing, the grain is placed in a *muru,* which is sealed afresh each time small quantities are withdrawn for food requirements or for making beer (*tembo*).

Sorghum.—The ears are usually placed on tables (*rutara*) in the sun for one or two months. Before the short rains the grain is threshed out and placed in a *githu,* in which it may be kept for six to nine months.

The grain is withdrawn by boring through the bottom or sides of the *githu* and afterwards plugging with grass.

Grain for seed purposes may be stored in a *githiri,* or selected ears may be hung from the roof of the *nchuku.*

Pigeon Pea, Njahi (*Dolichos lablab*) *and Cowpea.*—Pods are stored for a

month or so in the *nchuku* and after threshing the grain is placed in a *githu*.

Seed of pigeon pea is frequently stored in the pod in a *muru*. Seed of *Dolichos* and cowpea is generally placed in a *githiri* well sealed with cow-dung.

Green Gram.—Pods are stored for a short time in the *nchuku*. A large proportion of the crop is sold immediately it has been threshed, but the remainder is placed in a *muru*. For seed purposes the unthreshed pods are stored in a *nyungu*.

MERU GRAIN STORE
[Native name : *Nchuku*]

Eleusine and Foxtail Millet.—These crops are treated like bulrush millet. They may be stored in a *muru* for as long as two years.

Maize. — The cobs, complete with sheath, are tied around trees or poles in the open by means of the outer wrappings. The grain may be stored thus for about a year, but the ends of the cobs tend to get weevilly.

IV—BY THE WAKAMBA, IN THE MACHAKOS DISTRICT OF KENYA

By M. H. Grieve

In describing the Wakamba method of food storage it should be borne in mind that while the main arrangements follow general custom fairly closely there are local variations in detailed procedure.

The Wakamba generally thresh out all their grain and legumes immediately after harvest; the only exception is maize, which is stored in the cob. The threshed grain is immediately put into sealed containers.

A grain store in this district is called an *ikumbi*. It is a large beehive-shaped structure made of bent sticks of *muthata* (*Olea chrysophylla*) or *mukuswi* (*Acacia pennata*). The whole is raised two feet off the ground on piles driven into the earth. There is no separate roof and the whole store from top to bottom is covered with thatch. The opening is at the base, and is just large enough for a person to crawl in. The floor is made of sticks covered with grass and is not smeared with clay or cattle dung. The *ikumbi* is from six to eight feet high and roughly the same in diameter. Normally it is used as a shelter for small food receptacles, and loose grain (with the exception of maize cobs and finger millet) is never put into it.

The container next in importance is the *kiinga* (plural *iinga*). This again is a basket-like structure, but unthatched and cone-shaped, with the opening (about one foot in diameter) in the top. The *iinga* are kept inside the *ikumbi*, and are frequently so large that the *ikumbi* is built over the *iinga* as they lie, as a sort of shelter for them. A large *ikumbi* may shelter up to three *iinga*.

The *kiinga* is made of the same kind of withies as the *ikumbi*, but interwoven with twisted grass, which makes a very strong, insect-proof job. A *kiinga* may be

up to three or four feet wide at the base and four or five feet high. The lid is made of sticks and clay or cattle dung, and is sealed. These containers are so strong that they are known to have been in use for twenty years.

Calabashes or *ikuu* (pumpkin-shaped) are commonly used for storing food, and are kept together with *iinga* in the *ikumbi*. They are sealed up with a plug of cloth or the core of a maize cob.

Earthenware jars or *nyungu* are also kept in the *ikumbi*, and are sealed with a lid of sticks and clay or cattle dung.

No food except that for immediate use is ever kept in the dwelling-houses, and as a rule the only seed kept in the living quarters is maize, the cobs being attached to the rafters. When food is required the owner opens up the door of one of his *makumbi* and crawls inside. He opens the lid of a *kiinga*, and if it is full he can ladle out the grain with a calabash cup. If the level of the grain in the *kiinga* is getting low, he must tilt it to pour it out. Then the lid is replaced and sealed.

The Wakamba do not mix ashes or earth or any other foreign matter with their grain.

Any kind of grain can be kept in calabashes or earthenware jars, but maize and beans are never kept in *iinga*, which are used for all other kinds of food, such as pigeon peas, millet, sorghum, cowpeas, and finger millet.

ROSES

"The doyen of garden roses is the old Provence or Cabbage Rose, *R. centifolia*, for it is generally held to have been the 'Hundred-petalled Rose' of Theophrastus; but the closely inter-related group, which comprises *R. centifolia*, *R. gallica* and *R. damascena*, is of prehistoric antiquity. Their native home is probably in the neighbourhood of Persia and the Caucasus, with extensions westward; and several indications point to Persia as the centre in which the rose was first developed as a garden plant.

"The Provence Rose is more than a museum piece of antiquity, for it is an admirable example of the globular design, and its scent is still almost unmatched for delicacy and freshness. The old garden form of it, the 'Provincial Rose' of Shakespeare, is a heavy buxom rose in pale pink deepening towards the centre, but a less attractive variety in dark carmine pink is commonly sold for it to-day, and we shall do well to ask for 'Rose des Peintres,' an eighteenth-century form whose portrait was often painted by Van Huysum, for it scarcely differs from the old pink 'Cabbage Rose,' except that it is slightly smaller and more refined.

"*Rosa gallica*, according to legend, was brought by Thibaut le Chansonnier, fourth Count of Champagne, from Palestine to the town of Provins in the thirteenth century; and there it flourished so well that it gave rise to a local industry, and provided the whole of France with dried rose petals for making the ruby-coloured syrup of roses, which was the medieval equivalent of pink pills for pale people. Edmund Crookback brought it to England on his coat of arms after he had become a Count of Champagne by marrying the widow of Henry the Fat; and, as the 'Red Rose of Lancaster,' it is emblazoned on his tomb in Westminster Abbey. The form grown at Provins was a semi-double rose with solid, purplish-red petals, which retain their colour and scent when they are dried, and are therefore particularly esteemed by the apothecary, so that this form was known as *R. gallica officinalis* (i.e. 'of the druggist's shop'), and in English as 'The Apothecary's Rose'." —Jason Hill, *The Curious Gardener*.

NOTES ON SOME PESTS OF MAIZE AND MILLETS IN UGANDA

By H. Hargreaves, A.R.C.S., D.I.C., F.R.E.S., Senior Entomologist, Uganda

This article is a review of knowledge gained during occasional observations by the writer over a number of years. It is thought that the notes may prove of interest and use locally and that they may serve as a guide in the work of agricultural officers and others in close contact with these crops under African peasant cultivation.

The several species of locusts which often do intense damage to cereal crops are not dealt with here.

Maize

(1) *Stem Borers ("Ndiulira," Luganda)*

(*a*) *Busseola fusca* Hamps.—The first Uganda record of this (in other African territories) well-known insect was made in 1922. Since maize is rarely grown on any but small plots or in mixed cultures in this country, this, and other pests, have rarely been brought to notice. The insect is distributed throughout the Protectorate, and is a major pest of the crop.

The following notes resulted from a brief general investigation made during 1930-31 in connexion with an outbreak of stem-borer on a plantation of 600 acres —by far the largest single area ever grown in this country.

Damage.—Attack by young larvæ commences on the young leaves at the top of the plant and extends downwards through the rolled leaves into the soft stem apex, which is killed, and further apical growth is rendered impossible. Migration to other plants occurs in search of suitable food. Older larvæ bore into and along the stems, gaining entrance either at the apex, inside the sheaths of young cobs, or beneath the sheathing leaf-bases. The younger or softer tissues are preferred. On older plants, when entrance to the stem is difficult, much damage may be caused by the caterpillar feeding on the developing seed. The injury to the stem, especially in younger plants, causes a serious reduction in the size and number of cobs, and may result in death of the whole plant.

The presence of the caterpillar in growing plants is shown fairly early by the nibbled and holed leaves, and later by the withering of the tops of plants. Attacked sorghum stems show red streaks and emit a vile odour.

Food-plants.—Other food in Uganda includes sugar-cane, sorghum and *Pennisetum purpureum.*

Life-history.—Eggs are laid attached to the plant or in loose clusters under the sheathing base of the leaf, and are thus protected. In captivity such groups numbered from 8 to 140; unattached eggs adhere loosely to one another in groups up to six. The incubation period (December) was ten days.

On hatching, the young larvæ climb to the top of the plant and first nibble the surface tissues of young leaves, later eating holes, and subsequently boring through the curled leaves, which characteristic damage becomes apparent when they have unfurled. The young male inflorescence is also attacked. (For other larval habits see "Damage" above.) After seven to eight weeks (in captivity) the larva becomes full-grown and prepares a chamber in the stem, usually near a node, with an exit hole protected by a thin membrane of tissue, and pupates.

The pupal period was 15 to 16 days in every case during all months of the year.

The pre-oviposition period is three to five days, and eggs appear to be laid all within a short period. In captivity a paired female laid 249 eggs in two days and an unpaired female 123 in six days, surviving respectively six and ten days without food. Under natural conditions the egg-capacity is very much greater—probably about 1,000, as suggested by South African entomololists.

Description of Stages.—The egg is circular in outline with flattened base, subhemispherical, about 0.6 mm. in diameter and 0.48 mm. high, creamy white, with fine ridges radiating from an almost flat, circular apical area.

The larva is of variable colour, especially in younger stages when the head and pronotal plates are black and the body white to dark brown. The full-grown larva is about 32 mm. (1¼ inches) long, with reddish-brown head, brown pronotal plates and dorsum of ninth abdominal segment, and the body pale brown, dirty whitish, or purplish with tiny, paired, black spots and sparse hairs.

Natural Enemies.—The Braconid, *Apanteles sesamiae* Cam., is a common parasite of the caterpillar, and its small, compact white cocoon may be found in groups of forty or more, often under leaf-bases.

Seasonal Incidence.—A year's observations at Kampala and a few others in Bunyoro and elsewhere suggest a much higher incidence of the pest in sowings during the period March to June than in later sowings, in which the infestations of *Busseola* (and of *Sesamia* sp.) were negligible. This severe early incidence of the pests may be connected with the abundance of wild hosts in suitable condition, which result from copious rain succeeding clearance by grass fires.

Control.—The normal method of cultivation of maize by Uganda natives for their own consumption, in the wetter areas especially, in some ways greatly encourages damage by stem-borers. Series of small sowings provide a continuous supply of young plants over a considerable period; plants which have been killed by borer are left standing until they are felled by termite attack at the roots, thus allowing the contained borers to mature and infest growing plants. On the other hand, the growth of scattered maize plants in mixed culture will tend to reduce damage. Reduction of infestation may be achieved by cutting tops off younger plants early after attack and immediately destroying the tops (by feeding to animals, crushing or burning), by crushing any caterpillars which may be seen about to enter cob or stem, and by the early destruction by burning of old plants withering as a result of attack.

In the case of large pure stands of maize the first and third of the above control measures are applicable. Where such cultivation is supervised by responsible persons, clumps of plants sown a few weeks in advance of the main sowing can be utilized to induce concentrated laying of moths then present; such trap-cropping will delay and tend to prevent serious infestation of the main crop, but care is required to ensure that the trap-plants and contained caterpillars are destroyed in time to prevent spread of the insects to the crop. Maize plants become attractive to the pests when about one foot high.

If a second sowing of maize is to follow on the same land immediately after harvest, it is of special importance to ensure that all old plants (including bases of stems) be destroyed forthwith in order to kill any borers present.

In recent years control of stem-borers by applying to the top of the plant liquid insecticides containing derris extract has

been developed, and such top-dressings are now used on a commercial scale in other countries.

(*b*) *Sesamia calamistis* Hamps., *S. cretica* Led., and *S. vuteria* Stoll.—These species were first recorded in Uganda in 1921, 1930, and 1926 respectively. They have not been studied in any detail, but they appear to be very similar in habits. In maize they bore the stem and cob, but they are usually much less common and hence of lower pest status than *B. fusca* in this country. *S. cretica* is apparently rare, although the similarity of the caterpillars renders field identification difficult. The single pale brown chitinized plate on the pronotum and the different chætotaxy (arrangement of bristles) of *S. vuteria* distinguish this caterpillar from that of Busseola.

S. vuteria is known also from the stem of sorghum, *Eleusine coracana*, sugar-cane, and *Pennisetum purpureum*. A Tachinid fly, as yet unnamed, is parasitic on the caterpillar.

(2) *Leaf-eating Caterpillars*

At least seven species (apart from cut-worms) attack maize leaves, but none has been known to cause serious damage.

(*a*) *Melanitis leda* Linn.—Feeds also on *Pennisetum* and *Digitaria* sp. The larva is pale green, with a pair of short, hairy, brown, erect, horn-like appendages on the head, and a pair of similar but horizontal and green appendages at the tip of the abdomen.

(*b*) *Parnara gemella* Mab.—This feeds also on sugar-cane. The egg is laid singly on the leaf; it is pale creamy white, almost circular in outline, dome-shaped with flat base, about 0.9 mm. diameter by 0.55 mm. high. Egg period about seven days. The larva is very pale green with darker longitudinal lines and blackish or reddish-brown marked head; this stage lasts 30 to 33 days. The pupal period is 8 to 11 days the pupa being tied to the leaf. The Eulophid parasites, *Pleurotropis telenomi* Crawf. and *P. violacea* Waterst., have been reared from the eggs.

(*c*) *Cirphis loreyi* Dup.—This was moderately common at Kampala in the latter part of 1929. Eggs are laid on the leaf in small groups (in one case ten were found in the tip of a leaf folded by *Marasmia*). The caterpillar is pale brown, with broken, dark brown longitudinal lines; it feeds for 24 to 28 days. The pupal period is 13 to 18 days and is passed in the soil.

(*d*) *Marasmia trapezalis* Gn. — The caterpillar sews together the two edges of a leaf near the tip and feeds within on the tissues to the lower epidermis; it is yellow when young and green in older stages, with fine black rings around the bases of single or paired setæ. The pupal period, passed within the leaf-roll, is nine to ten days. The grass, *Panicum trichocladum*, is a wild food-plant. An undetermined Tachinid parasite has been obtained from the caterpillar.

(3) *Seed-eating Caterpillars*

(*a*) *Eublemma brachygonia* Hamps.—This small larva attacks the tassel and young seed of the cob, and the seed of sorghum.

(*b*) *Argyroploce leucotreta* Meyr. (False Codling Moth).—It occurs in this country as an occasionally major pest of maize, but is more widely known here as a cotton bollworm of major importance.[1] The caterpillar burrows into and among the young seed; partially damaged seeds decay and attract small beetles, such as

[1] In South Africa this species is an important pest of citrus fruit and appears not to attack cotton or maize, while in Tanganyika Territory it was not recorded on cotton until recently and apparently does not occur on maize.

Carpophilus sp., which increase to some extent the original damage. At Kampala, in 1930, sowings in the earlier rains suffered considerable damage, whereas the second crop, grown at a time when cotton was bolling, was practically free from the pest.

Other food-plants of *A. leucotreta* include a very wide variety. Those so far recorded in Uganda comprise orange, castor oil, sorghum millet and *Ziziphus* sp., together with many species of Hibiscus. (T. H. C. Taylor, in MS.) In all cases the fruit or seed is the part attacked.

This insect has been studied more closely in its role as a cotton pest, and a more detailed account has been prepared for publication elsewhere. For the present purpose a brief outline of the life-history and a short description of the larva, to enable it to be distinguished in the field, must suffice.

The tiny, oval, scale-like, semi-transparent whitish eggs are laid singly or in small groups, and they hatch after five days; the larva feeds for about 18 days, then making its cocoon of silk and debris either under the spathe leaves of the cob or on the soil surface; the pupal period is about 12 days. Egg-laying commences within a few days of the emergence of the small brownish moth.

The caterpillar, though somewhat variable, is typically light red on the upper surface, with head and pronotum brownish. At times, and more frequently in its younger stages, the general body colour is dirty white. The full-grown larva is about half an inch long.

(4) *Cutworms*

These caterpillars, which in general are usually dull-coloured (brownish or greyish) and of greasy appearance, probably include several species of similar habit, but *Euxoa longidentifera* is the only one so far definitely identified by rearing the adult moth. This species attacks a wide range of herbaceous plants (both cultivated and wild) as well as some more woody types in their succulent stage of growth. The caterpillars, when not feeding, burrow just below the surface of the soil, and may be found during the day hidden near the bases of plants. The insects cut off the plants near the soil surface level.

The factor generally responsible for intense attack is the removal of the normal food of the insects by weeding, either immediately before planting out seedlings or after a dense growth of weeds has developed among the crop. It is advisable therefore, when opening up land for sowing or planting of crops, either to do this during dry weather, when the cutworms present will largely die of desiccation or starvation, or, if the preparation must be done in rainy weather, to delay putting out the seed or plants for two weeks after complete weeding. During early growth of woody-stemmed crops (and probably those of herbaceous type), the weeding of alternate interlines successively will avoid driving the cutworm to feed on the crop, as occurs when all weeds are removed at one time; to allow weeds to grow to a thick mat and then clean weed is likely to induce cutworm attack.

(5) *Other Insects*

(*a*) *Rhopalosiphum maidis* Fitch. (Aphid)—Moderately severe infestations sometimes occur inside leaf-bases and on the flowers of both maize and sorghum. The insect is only a minor pest.

(*b*) *Cicadulina mbila* Naude. — This small greenish bug (leaf-hopper) is rarely common. Its importance is due solely to the fact that it is a vector of streak disease.

(*c*) *Megalognatha rufiventris* Baly.[1]—A small black beetle with pale reddish-brown abdomen appears in large numbers, usually in April and May, and causes intense local damage to many plants. In the case of maize the young tassels and seed embryos are eaten. Flowers of almond, dahlia, peach, loquat, mango, rose and avocado (the whole of a large flowering of some trees was destroyed in 1936); young leaves of *Albizzia Brownei,* almond peach, custard apple (*Anona*), *Crotalaria alata* and *C. juncea* are also eaten.

Nothing is known of the immature stages, which are believed to occur in the soil.

(6) *Birds*

A large colony of weaver birds caused much damage to maize on a European-owned farm by attacking the cobs (in addition to green peas). Shooting failed to stop their depredations. A trial of soaked rice sprinkled with Paris green as a bait proved ineffective. Rice soaked in a saturated water solution of corrosive sublimate for half an hour and laid on the bare ground as a bait immediately disposed of the birds.

SORGHUM

(Stem-borers are dealt with under "Maize.")

(1) *Seed-head Caterpillars*

(*a*) *Lycaenesthes definita* Butl., a slug-like larva, green with short oblique red lines and spots, is known from Kampala, Toro and Kabale.

(*b*) *Salebria* sp. (?).—Feeds also on maize. The caterpillar is olive brown and about half an inch long when full-grown. It appears to be only a minor pest.

(*c*) *Lobesia sitophaga* Meyr.—Reared also from seed-heads of *Leonotis*. Larva pale green with brown head and paired, black pronotal plates.

(*d*) *Sitotroga cerealella* Oliv. — The seeds are attacked when ripening, but the main damage occurs during storage, breeding continuing unless the moisture content of the seeds is reduced below the minimum necessary. Preliminary tests in 1936 indicated that slightly less than 15 per cent moisture is the maximum allowable to avoid such damage. With moisture content of about 25 per cent and at temperatures around 78° F. the length of one generation is 29 days; reduction of temperature and moisture reduces the rate of development of the insect and hence also the rate of damage. Sorghum seeds with 15.7 per cent moisture, stored in sealed jars, kept for nine months with only moderate damage, while 17.7 per cent moisture in the seed resulted in total loss (as food for human consumption) within three months.

(2) *Other Insects*

(*a*) *Acrocercops fustigera* Meyr.—The tiny caterpillar mines the leaves, but the damage is negligible.

(*b*) Stem-maggot (*Antherigona* sp. ?).—Several of these fly-maggots occur in one plant, and they feed in the soft apical tissues of young plants, causing death of the top, which results in tillering. Only one instance of such damage has been recorded.

(*c*) *Calandra oryzae* Linn.—This is the well-known rice weevil and is also a serious pest of maize. Infestation may commence in the field, but extensive damage occurs only during storage of grain if it is not thoroughly dried and kept dry; 15 per cent moisture is the

[1] There is some confusion regarding the identity of this insect, and it is possible that the species is *M. bayeri* Laboiss.

maximum degree allowable to prevent damage by the weevil in stored sorghum.

Eleusine

Damage by insects (excepts locusts) to this millet is rarely extensive. Some of the pests are dealt with under "Maize".

(1) *Grasshoppers*

These appear to be the most common pests, and a considerable number of species are involved.

(*a*) *Chrotogonus* sp.—Attacks young maize, vegetables, and tobacco also. The practice in some areas of sowing the millet during the period preceding the rains appears mainly responsible for the damage by these surface grasshoppers which has frequently been recorded, particularly from the drier areas. The seed germinates after the first shower of rain and the insects, which normally live on almost bare soil, in the absence of their normal food immediately attack the tiny plants. Several successive sowings are often thus rendered necessary.

(*b*) *Zonocerus variegatus* Linn.—A prettily coloured grasshopper which attacks millet, cotton, coffee, cassava, *Ricinus,* and sweet potato, among economic plants, occasionally causing severe local damage.

(2) *Other Leaf-eaters*

(*a*) *Cyaneolytta rugipennis* Makl.—A black, elongate beetle, about one inch long, with rough wing covers and a conspicuous head. One instance of locally intensive damage to young plants is recorded.

A beetle of similar type (*Epicauta limbatipennis* Pic.), which is a quarter to a half inch long and of dark grey colour, also attacks this millet occasionally.

(*b*) *Epilachna similis* Thunb. — This phytophagous ladybird beetle was first recorded as a pest of grain crops in Kigezi and Ankole in 1932, when serious defoliation of *Eleusine* and rice, and some damage to maize, occurred. Further outbreaks have since been reported and only from these two areas; since the insect is distributed throughout Uganda its development as a serious pest in restricted areas is mysterious.

The groups of yellow eggs are laid on the leaf. The larva is yellow with black longitudinal lines; pupation occurs on the plant. Both adult and larva cause damage.

(*c*) *Army-worms* ("*Nkungulu,*" Luganda).—Periodical outbreaks occur at intervals of a number of years of enormous numbers of caterpillars which devastate grazing lands and millet areas. The species concerned are *Laphygma exempta* Walk., *L. frugiperda,* and possibly others also. Such an outbreak was recorded in 1936 in Teso, Northern Busoga, and Gomba County of Buganda. These occurrences appear to be well known to the peasants; in Gomba County the people have the belief that during the year after a visitation by these insects only bull calves will be born.

A GROUNDNUT WILT DISEASE ON THE COAST OF KENYA

By Norman Humphrey, Agricultural Officer, Kenya Colony

Introduction

The coastal soils of Kenya are mainly light, sandy loams, which one would expect to be well suited to the cultivation of groundnuts. Such is not the case, however, and a tour of the district soon reveals how small a part this crop plays in local agriculture. Here and there one may see a few groundnuts of the creeping type, but never in any great quantity.

In making proposals for the development of native agriculture therefore, groundnuts was one of the first crops to come under consideration, and before starting trials at Kibarani in 1931 it was natural to make inquiries why the cultivation of this crop was on such a small scale and whether the introduction of new varieties would make any difference. An almost complete drought had been experienced during the previous year, however, and no satisfactory explanations were forthcoming. Groundnuts "did not grow" or "died of drought"; neither reason was of much value.

In 1931 several varieties were obtained and planted in observation plots. Germination was satisfactory and good growth was made in the early stages. Soon after flowering began it was noted that some plants were wilting and dying off, and it quickly became apparent that this wilting would be the cause of serious loss. It appeared in all the plots and by the end of the season only one variety retained any healthy plants at all. This variety, a creeping type from Nyanza, lost only some 60 per cent of its population, the remainder ripening off normally.

Wilt Disease

Specimens of wilted plants were sent to the Senior Plant Pathologist for examination, and he reported that the wilt was associated with *Fusarium* sp. Characteristically, the first signs of disease in the field are the yellowing of the outer leaflets. In the next stage, the leaflets close together and collapse. The plant may then die off rapidly and completely; sometimes, after shedding much of its foliage near the crown, it may partially recover and set a small crop. This is more likely to occur on plants wilting late in the season, and almost certainly depends to some extent on climatic conditions. If a diseased plant is lifted, the taproot will be found to show signs of rotting. It may be noted that once the disease had been recognized, local inquiries confirmed its presence in native gardens, and it became clear that this was the limiting factor in the development of groundnut cultivation in the coastal area.

Trials in 1932

Observational trials were continued in 1932 with new varieties and with a bulk selection of the partially-resistant creeping type grown in the previous year. Results were similar to the previous year, and in view of this it was decided that the main work should consist of single plant selection and propagation in the creeping Nyanza variety, with the object of obtaining a highly resistant or, if possible, an immune strain, though trials of other new varieties would continue to be made as they became available. The presence of a groundnut wilt in America suggested the trial of a reputedly resistant American

variety, but it was found to be completely susceptible to the strain of wilt occurring in the Kenya coastal belt. Other varieties, both bunch and creeping, have been tried with no success—local types, almost certainly derived from the Nyanza creeping type, were found not to differ from it in their reaction to wilt disease. Of all the new varieties tried up to date, only one appears worthy of retention for future selection. This variety, Akola 10, may possess a considerable degree of resistance, and is of interest as it is a bunch type. In other respects, it is inferior to the new strains that have been derived from the original Nyanza creeping variety.

Selection in the Creeping Nyanza Type

Selection work was slow and limited in the early stages, and it was not until Kibarani was really established as an experiment station in 1934 that it became possible to undertake the work properly.

In 1935 some 30 plant-to-row strains selected from apparently resistant plants were sown. Although groundnuts are naturally self-pollinated, it was considered desirable to self a number of plants in the row. Accordingly, five plants in each strain were caged with muslin to eliminate all possibility of cross fertilization. A proportion of these died from wilt; the remainder suffered from the difficult conditions of growth but managed to set a small crop. Although some strains went down heavily with wilt, further experience suggests that wilt was comparatively mild in that season.

Out of thirty strains tested, twenty-four contained an average of 35.7 per cent wilted plants, one had 11.8 per cent wilted plants, and three had no wilted plants. A fourth had no wilted plants, but had germinated too badly to be taken into account. The plot on which the trial was made was known to be heavily infected with wilt, but the fact that the three apparently resistant strains were all together, in one area, suggested caution in considering the results, since they may have been planted on an area of less severity of infection than the average. Numerous re-selections were made in the best strains and these, together with the progeny of all caged plants that yielded a crop, were sown again in progeny rows in 1936. These progeny rows, however, showed great impurity for resistance, and further drastic discarding was carried out at the end of the season. All the three strains which had shown no signs of wilt in 1935 were seriously affected. Indeed, from only one of these (No. 3) have any of our latest strains been derived. On the other hand, the progeny rows from two caged plants (28/C/1 and 28/C/2) were markedly good, and in these a number of re-selections were made, the remaining plants providing seed for two small bulk plots.

In 1937 drought conditions were experienced during the greater part of the season. Plants bore but light crops, and some strains, notably an early maturing series, were unable to stand up to the continued dry weather. Some of the re-selections from 28/C/1 and 28/C/2 showed a large proportion of resistant plants. Several families were now finally discarded on grounds of insufficient resistance to wilt as well as lack of vigour.

1938 was generally a more favourable year for the crop, though excessive rain at planting affected germination adversely. The proportion of wilted plants in the selected lines was again low, and in Table I are shown the figures obtained in 1937 and 1938, comparing the behaviour in families with the general average of all the strains in cultivation.

TABLE I
GROUNDNUT WILT DISEASE

Family	Percentage Wilted Plants	
	1937	1938
	Per cent	*Per cent*
3	12·6	12·1
35	16·9	28·8
28/C/1	16·6	7·1
28/C/2	7·9	9·2
Average of all strains	25·5	9·5

Besides the progeny rows from 1937 selections, small bulk plots of the best 1935 and 1936 selections were planted again this season. In these bulk plots the proportion of wilted plants fell from 21 per cent in the 1935 selections to 8.1 per cent in the 1936 selections, whilst the progeny rows showed a proportion of 9.5 per cent wilted plants. Yield figures show that with wilt at this latter level a satisfactory return in crop can be obtained. It is possible that wilt has been mild this season, but the results give room for hope that groundnuts may be an economic crop for the coastal area in the near future.

YIELDS AND GERMINATION

Owing to conditions at the time of planting it was impossible to plant all the progeny rows at the same time. Excessive rain fell at that time, with the result that germination of the second planting was seriously affected and the yields of the later sown strains were generally lower than the early ones.

TABLE II
PROGENY ROWS—1938

Percentage Stand		*Yield per Acre
1st Planting..	70	1,341 lb.
2nd Planting	49	753 lb.
Average of all rows	59	1,025 lb.

*Yield taken after rejecting all plants bearing less than 30 nuts.

In the present season therefore, germination appears to have been the most serious limiting factor. If only the first plantings are considered, then the records show very little change in average percentage germination over the last four years.

In the selection work there was a possibility that germination might be correlated with wilt. High germination would indicate a vigorous stock, which might be less susceptible to wilt. In actual fact, however, no such correlation has been found to exist. The possibility that wilt might affect subsequent germination seemed not unlikely, but as drastic discarding of susceptible plants has been done annually any such correlation may have been masked. On the other hand, the fact that average stands have remained fairly constant in the selected plots, whilst wilt has decreased, suggests that any wilt effect must be very slight compared with other factors affecting germination. Hitherto wilt resistance has been the essential quality to be obtained. Selection has been based on this character whilst general vigour has been considered by discarding plants bearing less than an arbitrary minimum yield of nuts per plant.

While there are definite indications that germination is to some extent a varietal character, it is also clear that external factors are of at least equal importance in ensuring a good stand in the field. Some interesting data on this point have been collected, but more information is necessary before considering the matter further.

CULTURAL CONDITIONS

The possibility of reducing wilt by cultural means has also been considered. It has been noticed that in dry weather,

when wilt has begun to appear, a cultivation with hoes is followed by rapid wilting. Apart from this, with a heavy plant population, loss of a certain number of plants may not prevent a moderate crop being harvested. Planting therefore should be close enough to enable the groundnuts to make a good cover. At present the spacing used is $1\frac{1}{2}$ ft. x $1\frac{1}{2}$ ft., but it will probably be desirable, when the selection work is a little more advanced, to carry out spacing trials.

Mulching the surface was another practice that appeared worthy of trial, and accordingly in 1937 all bulk plots were divided into two, half mulched and half left unmulched. Seven strains were used, and in every case wilting was heavier and yields were far lower on the mulched plots than on the unmulched.

There is a further possibility, namely that some protection from wind may lessen the incidence of wilt. With small bulks becoming available, this can be examined by interplanting groundnuts in a crop which can give them some shelter. Such an interplanting experiment with cotton has been made in the present season, but it will need to be repeated under rather different conditions before any satisfactory conclusions can be drawn from it.

Summary and Conclusions

The incidence of a wilt disease of groundnuts in the coastal districts of Kenya is described. Variety trials show that a creeping type from Nyanza appeared to possess some degree of resistance, and selection work in this type has been carried out over a number of years. The results to date are described, and indicate that some of the strains evolved possess a high degree of resistance. If confirmation of this is forthcoming, the successful introduction of groundnuts into coastal agriculture should be possible. Other varieties introduced have been generally susceptible; only one, a bunch type named Akola 10, is being retained for further trial.

High germinating capacity is essential for a full harvest. Germination is perhaps to some extent varietal, but external factors are of equal importance in ensuring a full stand.

Cultural practices, as methods of lessening the effect of wilt, are briefly mentioned. It appears desirable to plant close enough to ensure the groundnuts forming a cover. Mulching, on the other hand, would appear to favour the incidence of wilt. It is also considered possible that protection from excessive wind would lessen wilt, and this point is being studied further.

AVOID JARGON

"Despite much practice to the contrary, any biological fact which concerns us can be accurately described and the conclusions from its study be clearly expressed in relatively simple and direct language. In research reports and scholarly discussion there is need for the conciseness and precision made possible by technical language. Science has no need, however, and is ill-served by any tendency to develop a cult of obscurity. Scientists must be free to attack the unknown as effectively as they can, and in return for intellectual freedom they have an obligation, which rests heavily on those able to do so, to interpret research results in terms which can be understood by intelligent and interested people."

—W. L. Allee, *The Social Life of Animals*, 1938.

THE OYSTER NUT

TELFAIREA PEDATA (NATIVE NAMES: KWEME, JICONGA)

By W. J. Poppleton, Makuyu, Kenya Colony

The oyster nut is produced on a vine of the family Cucurbitaceae indigenous to East Africa, and it grows at altitudes varying from a few hundred feet to 6,000 feet or more. The seed is not a true nut, but is called so from its size, colour and texture. Its fastest growth is at lower altitudes, but at higher altitudes it lives longest.

The large yellow nuts are contained within gourd-like fruits which attain a length of from 12 to 20 inches, a diameter of from 8 to 12 inches, and a weight of approximately 30 lb. The quantity of nuts in the fruit varies from 80 to 170; the average number is estimated to be 140 per fruit. An average-sized fruit brought from Tanganyika and opened at a Makuyu meeting contained 155 nuts.

The nut consists of an outside strong fibrous and bitter-tasting husk, covering a thin hard shell, within which is the kernel, covered by a thin greenish skin, similar to the skin on an almond.

It is a fast grower where conditions are favourable, and in support of this it is officially recorded of a vine at Embu that it attained a length of 38 feet with a stem of 2 inches diameter in fifteen months. At Makuyu, four vines from seed planted at stake in October, 1938, had attained lengths of over 20 feet by the end of April, 1939—a period of six months from germination.

It is a hardy, deep-rooted, gross-feeding, drought-resisting plant, and where conditions are favourable it produces for twenty years or more. When not controlled by pruning it attains a length of over 60 feet, and will completely overrun trees 40 to 60 feet in height, very often killing the tree and crashing it by its weight. Measurements taken of the stem of a vine 12 years old showed diameters of 6 inches at the base and 3½ inches 30 feet from the base.

The vine seems to thrive best on medium loams with good drainage and a rainfall of 35 inches or over. It grows vigorously on deep, well-drained black soil also. Where it was seen cultivated on flat, poorly drained soils of light pink and yellowish colour its vegetative growth was inferior and of much greater variation, some vines having attained a stem diameter of 2 inches in thirty months, while adjacent plants were much thinner and not vigorous. Production varies greatly according to conditions. One plantation with soil similar to that planted with coffee adjacent to it produced approximately three-quarters of a ton to the acre, whereas a block planted at a lower level in hard soil almost adjoining produced less than half a ton per acre.

Instances can be quoted of vines grown by the writer under the most adverse conditions at Ruiru, 1926-1928, where the soil was very shallow and underlain by rock and murrum. These vines produced crops for many years, though their productive life would be shortened by such conditions.

The vine is diœcious, and approximately five to seven male plants are required per acre. There is no way of differentiating male from female until they flower, which is about fifteen months after planting under favourable conditions. The male plant is believed by the writer to flower earlier than the female. The fruit takes about four months to mature. A Tanganyika plantation was visited which had been planted for two and a half years

and had already produced a crop of just over half a ton of nuts to the acre. At the time of this visit the vines were in full flower, the second crop being due to mature four months later. This represented a second crop within three years, and from then on the plants would produce one or two crops annually. At the time of the writer's visit to Tanganyika in August it was quite usual to see vines bearing almost mature fruits while at the same time they were flowering heavily. A vine visited at Embu was bearing seven fruits almost mature at the end of August, but this vine was growing under most unfavourable conditions, which might account for unseasonable cropping.

Opinions as to the percentage of male seed vary, but Tanganyika planters rate it at about 50 per cent. Germination is not good, it being stated at Embu that as much as 25 per cent fails to germinate, whereas in Tanganyika this is considered to be about 2 per cent. Makuyu planters report losses of 40 to 75 per cent, and the writer is of the opinion that if better selection is made of fully mature seed from cultivated plantations where there are sufficient male plants, the percentage of sterile seeds will be greatly reduced.

When considering the number of seeds required to establish an acre of plants, loss in germination, excess male plants and replacement of weakly or damaged plants must be taken into consideration.

In Tanganyika the vine is attacked by root-knot eel worm (*Heterodera marioni*), but this appears to occur only where the vine is cultivated in dirty areas previously used by natives. Apart from the use of lime dressing of the soil, no other treatment appears to be used. An excellent article on the subject, by W. V. Harris, Entomologist, Agricultural Department, Tanganyika, appears in the July (1937) isue of this Journal. Though it cannot be stated that mealy bug will not make it a host, it has not been known to do so in mealy-bug infested areas, and this is confirmed by Mr. Chambers, Agricultural Officer, Embu, who informed the writer that, although mealy bug had attacked many other plants closely adjacent, he had not observed it on the vines. Mealy bug taken from coffee and placed on vines at Makuyu did not live, although there were numerous ants using the vines to get to the foliage of the tree on which they were creeping.

Other pests are porcupine and ground squirrels, which dig up seed planted in the field at stake, and buck and grasshoppers which eat the very young shoots immediately after germination, but the leaves of plants a few months old do not appear to be palatable to them. Raising in nurseries initially is therefore preferable to planting at stake.

It is only reasonable to suppose that a plant which produces such a quantity of vegetative growth and crop will require regular feeding. A routine programme of manuring should be commenced from time of planting. Green manure, compost and boma manure should be turned in liberally, and these aided by bone or fish meals if available.

Vines will extend runners to lengths of much over 60 feet if not controlled, but it is reasonable to conclude that such vines are using most of their energy in vegetative growth at the expense of fruit production. The grape vine, if allowed to run uncontrolled, would not produce either the quantity or quality of crop it produces when properly pruned and cultivated. This vine will likewise give its best results when pruned and grown on properly constructed trellises. Experiments were made of growing it on the soil surface, but the results were unsatisfactory.

A vine conditioned and controlled would cover a space of approximately

540 square feet, or say 12 feet by 45 feet, which would allow for 82 vines per acre; say, 77 female and five males. It is considered by certain growers in Tanganyika that not more than two, or at the most three, runners should be allowed to develop from soil level to trellis height, after which runners should be allowed to cover the space in a manner which would allow for open growth. Where vegetable growth is dense, sufficient should be removed to assure this.

The different systems of planting used are as follows:—

(1) A single line of vines, approximately 12 feet apart and the lines widely spaced at intervals of about 45 feet. Vines under this system are trained with one, two or three runners from base to trellis height, after which they are allowed to spread in all directions within their allotted spacing of 12 feet by 22 feet 6 inches on both sides of the line.

(2) A double line of vines 12 feet apart with vines at intervals of 12 feet, training runners to trellis as in (1), but training them to creep in spaces 12 feet by 45 feet on the trellis in opposite directions; each set of lines being 90 feet apart.

(3) Similar to (2), but with double lines of vines 20 feet apart.

Under systems (2) and (3) a vine would be trained to extend its full length in one direction (45 feet), whereas under (1) the vine would be trained to extend two ways to $22\frac{1}{2}$ feet in a 12 feet width. The writer prefers system (1). By using system (1), in the conversion of doubtful coffee areas planted 9 feet by 9 feet, every fifth line of coffee could be removed, leaving the intermediate lines to bear crops. It is quite probable that the shade of the vines would benefit the coffee, at least for a time. System (3) would be the most suitable if the trellising was lower than 6 feet or 7 feet.

Trellises used in Tanganyika for supporting the vines are massive, as forests are nearby. The vine needs strong support, but if cedar uprights (whole or split) or other suitable timbers, 8 feet to 10 feet in length and from 4 inches to 6 inches in diameter, and 30 feet lengths of wattle or thin gum poles for horizontals, are available, these would meet requirements admirably. Strong, thin, 12-14 oval fencing wire could be used as cross horizontals. The trellis suggested for many parts of Kenya would be cedar uprights, spaced 15 feet by 15 feet (193 to the acre), 7 feet above ground; of this number there would need to be approximately ten to fourteen strainers 10 feet long and 3 feet below ground (with the intermediates of 9 feet and 2 feet below ground).

The number of strainers would depend on circumstances, such as contours and the shape of the block, and is a matter for individual planters to decide. Horizontal poles of 30 feet long should be fixed one way only. After this wires should be strained and fixed by staples at say 5-foot intervals crossways. Thin sticks laid across the wires would help to train young runuers from wire to wire. The wire recommended has a breaking strain of 1,200 lb.; each roll contains 1,500 yards, and costs approximately Sh. 25; two rolls would be required per acre. In Tanganyika uprights were spaced 12 feet square, but there was no indication that even the strongest growth needed such heavy support.

Lower than 6 feet to 7 feet trellising could be used where trellising is not required to cover any other crop, and where the plantation is situated at considerable distance from forests, making the supply of timber expensive. If such low trellising were used, however, it would need to be erected in sections of 90 feet width, by length according to the block, with space between each block of 20 feet in

which the vines would be planted, this space being necessary to facilitate cultivation, manuring and supervision. The planting would be in double rows as referred to in (3) under spacing above.

All three systems of planting represent approximately 82 vines to the acre. The amount of seed to ensure a sufficient number of female vines and to cover bad germination, weak plants, etc., should be reckoned at not less than 400 per acre. Since there is no way of distinguishing between male and female from seed, seedlings should be planted at half the eventual spacing of the vines. Therefore under all three systems seedlings should be planted at 6 feet apart.

Seed should be soaked for five days before planting in the nursery. Good seed will germinate in two to three weeks, and seedlings should be two to three months old before planting out in the field. Though plants do well in good soil from seed planted at stake, the nursery offers the necessary protection against porcupine, squirrels, buck and grasshoppers, and makes the watering of seedlings much easier if the season is unfavourable.

The vine grows by layering and develops vigorously. This is a simple method of propagating female plants to fill gaps. Prunings also, when left on the ground, have been seen striking where shaded and in moist soils. Individual transplantation from cuttings has been successful in Tanganyika. Slips from female vines could be used to replant gaps left by the removal of a series of male plants. It is better, however, to have a considerable number of seedlings in the nursery for this purpose, as the planting of slips in the field at Makuyu has not proved a success.

The vines do not thrive when exposed to strong or cold winds. If possible, a sheltered position with an eastern exposure should be chosen.

When the gourd ripens it commences to split open, exposing a salty-tasting, fibrous, pulpy mass, within which there are several rows of nuts running longitudinally. If left on the vine to ripen, the gourd opens gradually, and after a time the fruit dries or rots, releasing the nuts. Nuts ripened in this manner are fully mature and attain full flavour. It is believed that a great deal of the lack of flavour and failures in germination are due to picking immature nuts, it being customary in some places to cut the gourd from the vine immediately it shows signs of splitting. It seemed to the writer that this was about a week to ten days too soon.

The removal of the bitter principle can be done by a simple process of soaking the complete nut for eight hours in three changes of water. The writer is of the opinion that if the nut is left to fully mature within the gourd the bitterness can be removed by drying. This method is being tested.

Immediately after soaking, the nuts are sun-dried. All the appliances used for the sun-drying of parchment coffee, such as trays, tables, barbecues, are suitable for the purpose; artificial driers are not necessary.

The nut is not difficult to open by hand. If the husk is cut away from the edge to a distance of one-third to two-thirds of the circumference, the nut then placed edgeways and given a sharp tap, it will crack sufficiently for a knife to be inserted and the kernel to be taken out quite simply and without damage. A machine known as a belt sander decorticates quite economically. This machine costs Sh. 150, requires less than one-half horsepower to drive it, is quite small, measuring 28 inches by 13 inches by $8\frac{1}{2}$ inches, and can be screwed horizontally to a bench. A few tests showed that a team of four natives, two stripping the

nut and two removing the kernels, could decorticate 1,200 nuts, approximately 18 to 20 lb. of kernel, per hour. Allowing seven hours of this output in an eight-hour day, the total would be 126 to 140 lb.; say, for the purpose of estimating, 1 cwt. per day for four units of labour, which at 50 cents per day would cost Sh. 2 per cwt., or slightly less than 2 cents per lb. Other costs such as upkeep, depreciation of machine, power, etc., would cost less than 2 cents per lb. If these two costs are estimated at 4 cents per lb., the cost of decortication would be Sh. 89/60 per ton.

Economics.—The price paid for the nut by natives in Tanganyika, which seems to be a fixed price throughout the areas in which it is grown, is one cent per nut. Calculating the number of nuts to the lb. at 40, this represents 40 cents per lb. for the unhusked nut. As these contain approximately 60 per cent only of kernel, the price for the kernel is 66 cents or 8d. per lb. This price points to two factors: (1) that the native must hold the nut in high esteem to pay such a price for it, when he can purchase groundnuts at about 7 cents, or less than one penny, per lb. and produce them at even less than this price; and (2) that production must be well below local demand for such a price to be maintained.

Supposing the number of bearing vines is accepted at 77 per acre, the average number of fruits produced per vine at ten (this being a very low estimate), and the number of nuts per fruit at 140, the production of nuts per acre would be 107,800, which, at 40 to the lb., represents 2,695 lb. of nuts per acre, or 1,623 lb. of kernel. For purposes of estimating production, one-half ton to the acre is accepted. This is actually less than the first crop produced on young and not fully grown vines on one European plantation in Tanganyika, and is regarded as a safe estimate.

If the selling price of the kernel is accepted at, say, 8d. per lb., which is the price the native pays for it and is less than that estimated by the trade in London, the revenue per acre is Sh. 746/80, or £37-6-10. Consignments sold on European markets have fetched prices ranging from £50 to £100 per ton (5d. to 10d. per lb.). The lower price was for small and damaged lots which it is reasonable to suppose did not invite the interest of big buyers. The true market value will not be known until production has increased sufficiently to assure regular supplies to buyers who would use the nut in well-advertised special lines of confectionery. Increased production and shipment in larger lots would permit of better packing at more economic cost and prevent the damage which occurred in earlier, small consignments.

No figures of costs of production are obtainable, but it is generally considered by Tanganyika growers that these are much lower and the labour requirements much less than in coffee production. There are no expensive plant, fuel, factory, picking, and on-shamba transport charges, and field operations are much more simple. Routine manuring and mulching to maintain vigorous growth and regular crops will be necessary, but not at higher cost than that required by coffee. If this manuring is not done systematically there would be a deterioration of the nut after a few crops, the kernel will become lighter, there will be a corresponding decrease of fruits and nuts within the fruits, and vegetative growth would become less vigorous. The writer therefore considers that from first planting out some routine of manuring should commence, and this should be amply provided for in any estimated costs of production.

In the absence of any accurate data on the matter, the writer would estimate capital charges and the costs of production as under:—

CAPITAL COSTS PER ACRE (ESTIMATED)

	£	s.	d.
1. Upright spaced 15 ft. × 15 ft., 194 to the acre supplied at special rates, say 200 at 40 cents	4	0	0
2. 100 black wattle or other suitable poles, average length 31 ft. at 40 cents	2	0	0
3. Wire	2	10	0
4. Transport (5 miles at 40 cents per mile—6 loads)		12	0
5. Labour	2	0	0
6. Seed and slips, nursery work, planting and maintenance to time of bearing	3	10	0
7. Incidentals		10	0
TOTAL COST PER ACRE ..	£ 15	2	0

SHAMBA, PROCESSING AND MARKETING COSTS

	Per acre			Per ton		
	£	s.	d.	£	s.	d.
Soil cultivation, including weeding and thatching of areas within 12 ft. to 15 ft. of vines, green manuring and use of roughage brought into areas per acre ..	1	10	0	3	0	0
Manures per acre	1	0	0	2	0	0
Maintenance of trellis per acre		10	0	1	0	0
Pruning and general control of vines		10	0	1	0	0
Decortication	2	4	10	4	9	8
Soaking and drying ..		5	0		10	0
Tinning, say 40 tins at 25 cents (Sh. 10) and 20 cases at Sh. 1/50 (Sh. 30); other costs Sh. 30 ..	3	10	0	7	0	0
Transport to central factory		12	2	1	4	4
Railage, freight, insurance, commission, etc. ..	6	0	0	12	0	0
	£ 16	2	0	32	4	0

	Per acre		
	£	s.	d.
Revenue per acre	37	6	10
Less direct costs of production ..	16	2	0
Balance of revenue to cover overheads and profit per acre	£ 21	4	10

An example of how it is suggested this crop would convert an uneconomic plantation to an economic proposition might be shown as under:—

A plantation with, say, 100 acres of coffee may have only 40 acres of good quality plants capable of producing an economic crop at present prices. This acreage might produce, say, ten tons of reasonably good quality coffee, the remaining 60 acres of inferior plants producing only five tons of inferior coffee, making a total production of fifteen tons per annum from 100 acres, which sells at, say, an all-in local price of £35 per ton. This represents a total revenue of £525, and against this is set the cost of production, say, at £6 per acre, or a total cost of £600, a cost which makes no allowance for the excessive overheads many plantations are carrying, or for reasonable maintenance, and which would result in the ultimate complete deterioration of the whole area.

If only the 40 acres of better class coffee were retained, 25 acres were planted with oyster nut, and the balance of 35 acres planted with Napier grass or other equally suitable crops to provide manure for both producing areas, the economics (not allowing for crops from inferior coffee allowed to crop under the shade of the vines) would be as under:—

	£	s.	d.
10 tons better class coffee, say average £45	450	0	0
25 acres oyster nut at £37 6*s.* 10*d.* per acre (as shown above) ..	933	10	10
Total revenue ..	£ 1,383	10	10

Against this set the costs as under:—

	£	s.	£	s.	d.
40 acres of coffee, say at £10 per acre ..	400	0			
25 acres of oyster nut at 402	10				
Extra cost of napier grass and increase of overheads due to reduced acreage allow, say	150	0			
Production costs ..			952	10	0
Credit balance ..			£ 431	0	10

The above credit balance is estimated after allowing for increased costs sufficient to assure the soil and plants being maintained in good condition and a certain amount of reconditioning of the coffee areas.

By a steady annual increase of oyster-nut development the economics would be correspondingly improved.

If experimentation proved that the intermediate lines of inferior coffee left to crop below the vines were improved by shade and protection against exposure, the receipts from this also would add greatly to revenue.

Analyses of the Nut.—An analysis made by the Bureau of Chemistry of the New York Produce Exchange on the 12th July, 1938, was as follows:—

	Per cent
Shells	39·75
Kernels (meats)	60·25
Moisture in kernels	3·46
Oil in kernels	66·16*
Protein in kernels	26·94

*This is a high oil-content; normally not more than about 62 per cent could be relied on.

Possible Uses.—(*a*) The kernel can be used in confectionery and chocolate manufacture and in sweets and cakes, either alone or as a partial or complete substitute for Brazils and almonds.

(*b*) The oyster-nut oil can be used for household purposes; it is a high quality cooking oil.

(*c*) The oil is well suited for cosmetic manufacture.

(*d*) The kernel is believed to have medicinal properties. (Natives in certain parts of Tanganyika consider that the kernel has a most beneficial effect on lactation in humans.)

(*e*) The use of the kernel for patent foods because of its possible high vitamin content is being investigated.

(*f*) After expressing the oil, the residue makes a valuable cake for live-stock feeding.

(*g*) The native women in Tanganyika eat the nut during and after the period of pregnancy, as it is supposed by them to contain lactogenic and other properties. It appeared to me that production was very short of demand, and the writer found great difficulty in purchasing any except from European producers. This source was also very limited, as growers were selling the nuts for native consumption as fast as they were picked.

Grading for the Confectionery Trade.—It is suggested that whole kernels for the confectionery trade should be graded into three sizes: small, medium and large. It is thought that when trade has once commenced, the greater trade will be for the small size. This opinion may require modification if it is found possible to market the kernels as a dessert nut. All kernels which are not whole and unchipped should be packed separately.

The keeping qualities of the nut are good. Nuts which had been stored for about eight years were recently unhusked and found to be in perfect condition, in fact, they seemed to be improved by keeping.

Appreciation.—The author wishes to acknowledge his indebtedness to a number of Tanganyika planters of oyster nut from whom he obtained information, and to officials of the Kenya Department of Agriculture for their assistance in obtaining information incorporated in this article.

For further information on this crop readers should consult the article by R. J. M. Swynnerton that appeared in the May (1937) number of this Journal.—*Ed.*

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THE CONTROL OF THE COFFEE BERRY BORER IN BUKOBA

By T. S. Jervis, Senior Agricultural Assistant, Department of Agriculture, Tanganyika Territory

The coffee industry in Bukoba is probably unique in the world of coffee. Without subsidies, without any capital, without any of the labour associated with an enterprise of this nature, it sprang within a generation from an output of 214 tons in 1906 to 7,837 tons, valued at £478,311, in 1928, raising a people from comparative penury to pinnacles of wealth to which they are only now adjusting their mental equilibrium.

When Europeans first entered Tanganyika as residents about 1883 they found trees of the Robusta species already established in some of the native banana planations. The German Government, realizing the economic possibilities of the crop, encouraged further planting and introduced the Arabica species to the district. From 1903 the area under coffee was gradually increased and the export figures rose from 214 tons in 1906 to 681 tons in 1913. In the four years following the British occupation planting was given a great impetus, and exports were quadrupled. Thereafter the activities of the trade and a growing demand for coffee at high prices brought about the expansion of the industry which produced an export figure of 10,881 tons in 1935. Now the position has been reached where the produce of new areas coming into bearing is off-set by a corresponding decrease in yield from the earlier plots, so that further expansion waits upon an improvement in cultural methods.

Though coffee is grown throughout the district, the bulk of the crop is produced from the humid country adjacent to the lake shore, extending for 70 miles down the western coast of Lake Victoria, south of the equator. This strip is 12 to 15 miles wide and consists of a series of parallel ridges at a height of 4,500 to 5,000 feet above sea-level, running roughly north and south. These ridges are separated by wide, open valleys which expand towards the north into considerable areas of permanent swamp. The annual rainfall averages from 80 inches in the north to 40 inches in the south and west. Conditions in the north are therefore ideal for the cultivation of Robusta coffee, closely resembling those in its natural habitat, the rain forests of the Congo, and it is here in the banana plantations that this species achieves its maximum development, growing, where adequate space is provided, into a tree 15 feet high, covering an area of 700 square feet, and capable of yielding twenty pounds of clean coffee in a year.

Under the methods of cultivation practised by the natives these trees become enormous botanical candelabra with their branches spreading to the ground and from which sprang innumerable shoots, forming a dense canopy and affording complete sanctuary to the coffee berry borer (*Stephanoderes hampei*), which is no less indigenous to East Central Africa than the coffee tree itself. With the phenomenal increase in crop this pest multiplied rapidly, outstripping the biological control which occurred under natural conditions, and by 1929 over 90 per cent of the standing crop in these Robusta areas showed signs of borer damage. The infestation was heaviest in villages on the lower slopes of the ridges and the valleys where extremely humid conditions prevailed.

In 1928 the markets had paid £60 a ton for the virtual sweepings of the coffee plantations and the trade had literally scrambled for any form of coffee that it could lay its hands on, which was exported under the description, "Bukoba Coffee: a fair average quality of the season's crop." Obviously the trade was not concerned with any idea regarding pest control. The grower was in receipt of more money than was necessary to cover the domestic requirements to which he had been accustomed and he was only just beginning to learn how to spend. Loss of crop, or any suggestion regarding its improvement, conveyed little to him.

The first measures to check the damage caused by the coffee berry borer were introduced in 1929 and took the form of ventilating the trees by cutting back the low-lying branches and thinning out some of the heavy vegetative growth so characteristic of Robusta coffee. This permitted the air to circulate freely within the trees and so interfered with the flitting of the female beetle and localized its activities. At the same time all fallen cherry was to be collected and buried.

There are approximately 70,000 individual plots to be considered, though the application of measures to control the berry borer affects only half this number. The remainder do not present the problem which has to be faced in the humid northern area, for they lie in the drier southern and western parts of the district where Arabica coffee predominates. In Bukoba, Arabica coffee is seldom attacked by Stephanoderes, and in these areas it is not a major pest except along the lake shore and in the more sheltered parts of the valleys; even there it appears to be adequately controlled by its indigenous parasites.

When the control measures were first introduced much damage was done to the trees, which were cut about by immigrant labourers employed by the growers. They stripped off much new wood, whilst the rubbish under the trees was swept up and scattered in amongst the bananas, leaving the soil under the coffee trees bare and unprotected. Since at that time there was no economic necessity for enforcing the control measures advised, and as much damage had resulted from the application of these principles of control without showing any appreciable gain—because the fallen cherry had not been destroyed and the breeding grounds of the beetle remained—it was deemed expedient to discontinue propaganda, and no further action was taken.

By 1931 the quality of the exports had so deteriorated, principally owing to the impaired nature of the bean itself through borer damage followed by fungus attack, that the value of the crop fell by 73 per cent and it became necessary once again to advocate measures of control. The situation was serious. The confidence of lost markets had to be regained by exporting an improved quality of coffee. To try to effect this improvement without interfering with trade was realized to be impossible, and the export of trash was prohibited. At the same time the system of inspecting and grading all coffee exported from Bukoba, which has previously been described in this Journal [1], was introduced, providing markets with a guarantee that Bukoba coffee would not fall below a certain minimum standard. Throughout 1932, working back from the grader into the interior, pressure was maintained in raising the standard quality of the coffee, and the native grower was slowly educated in regard to the cultural improvements, including pest control, necessary to meet market requirements. Realization of the loss caused by the coffee berry borer was brought home to the grower by the fact that the trade was no longer able to export trash and stopped

buying it, so that the native, whose earnings had fallen heavily, had perforce to pay attention to the preparation of his crop. The elimination of all major defective beans from the fair average quality was the aim, and by the end of 1932 an officially defined "F.A.Q." grade was evolved, which was accepted by the markets and became the basis of all future contracts.

In order to maintain this grade and the growing demand for Bukoba coffees, it became essential that the spread of the berry borer should be checked, for the elimination of defective beans in the course of preparation was not sufficient, and steps were taken by the native authorities to bring this pest under control. The measures adopted were similar to those introduced in 1929, but instead of burying the cherries collected from under the trees, instruction was given in collecting the fallen cherry and burning it, thereby ensuring the destruction of the breeding grounds of the beetle.

The main Robusta crop, and this comprises two-thirds of the total coffee production in Bukoba, is picked between June and August, and a secondary picking takes place in November and December. The crop is left on the trees until the bulk is ripe, when it is stripped off, a certain proportion falling to the ground where it is left. Flowering occurs throughout the year, so that there is always a certain amount of coffee maturing on the trees and providing a harbourage to the female beetle wherein to lay her eggs. This means that complete eradication is impracticable, as stripping of immature crop after the harvest of the main crop cannot be contemplated. It remained, then, to choose a time when prophylactic measures would have the maximum effect and it was decided to carry out the work in September each year, because at that time the main crop was off the trees and the secondary crop insufficiently advanced to accommodate the egg-clusters of the beetle.

In 1933, after the growers had been instructed in the methods to be employed, these measures were brought into effect with outstanding results. The Robusta crops, which had been very nearly at a standstill since 1928 at an average of 5,200 tons, jumped in 1934 to 6,898 tons and in 1935 to 7,472 tons, with a corresponding improvement in quality. This September clean-up has now become a yearly routine practice, and the natives now appreciate the benefits accruing to them in the increased quantity and weight of crop and the reduction in the work involved in producing a marketable sample.

While these measures have given good results and have gained the grudging approval of the growers, they are not the only effects of the annual campaign against Stephanoderes, for it takes place at the latter end of the dry season in Bukoba and, although the rainfall in these coastal areas is high, the soil, being derived from sandstone, is porous and dries out rapidly if exposed for even a few days. Under normal conditions the effect of the mulch of disintegrating coffee and banana leaves lying under the trees is to maintain a uniform degree of soil moisture and temperature over a long period, preventing excessive drying out of the soil in the dry season and allowing of gradual absorption of the excessive rain in the wet months, while at the same time preventing surface wash. This results in the production of a dense mat of fine roots along the surface of the soil which are exposed to the drying winds when the surface mulch is swept aside in September and, as too often is still the case, is burnt wholesale with no attempt to sift out the coffee cherry. In a land where the

fertility of the soil, as described by Milne [2], is inherently low, the native has been slow to appreciate the secondary effects which haphazard methods in the control of the coffee berry borer produce. He cannot yet be expected to correlate the depletion of soil humus and the removal from circulation of the plant nutrients that are constantly being raised to the surface by the deeper roots, with a fall in his crop or with biennial bearing. Every effort has been made to discourage this thoughtless waste, stressing the importance of soil fertility by instruction and demonstration; and the application of these practices to the coffee trees is being brought home to the growers by analogy with the attention devoted to their banana plantations, in which the practices of mulching and manuring have been handed down from generation to generation. In addition, the grower is now learning to add to the existing mulch of disintegrating coffee leaves further organic matter in the form of grass, banana trash, crop residues and manure.

The problem may better be comprehended if it is remembered that some 35,000 growers, each with, say, 100 trees, might, in the haphazard collection of fallen cherry, remove and burn from 10 to 14 lb. of fallen leaf matter from under each tree. High yields can only be achieved through good soil management, and the misconception that the wealth of the grower is coffee is giving place to that ancient axiom of prosperity, "The people's wealth lies in the soil."

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[1] Jervis, T. S. (1936).—"Bukoba Coffee: Inspection and Grading," *East African Agricultural Journal,* Vol. I, No. 5, p. 366.

[2] Milne, G. (1938).—"Essays in Applied Pedology, III: Bukoba, High and Low Fertility on a Laterized Soil, *East African Agricultural Journal,* Vol. IV, No. 1, p. 13.

SOIL EROSION IN JAMAICA

Soil erosion in Jamaica forms the subject of a bulletin (No. 17) issued by its Department of Science and Agriculture. The greater part of the cultivated land is situated on steep hillsides, gradients of one in one being frequent, so that sheet erosion is the major problem. These slopes were originally covered by dense forest and undergrowth, the clearing of which has resulted in rapid loss of surface soil. The rate of loss depends largely on the crop grown. Bananas and coffee, for example, are comparatively widely spaced and are maintained under clean cultivation so that soil exposure is very serious, though the necessity for drains in the case of bananas somewhat alleviates the situation. Sugar-cane, on the other hand, is an excellent soil conserver as it has an elaborate root system and the trash deposited after reaping forms a protective cover. Of the less important crops the cultivation of yams, sweet potatoes, corn or ginger encourages erosion, but citrus causes little loss, as the trees are usually left in the grass cover. Erosion is also promoted by the otherwise valuable system of forking the soil at the end of the dry season to facilitate the penetration of the first rains, and by the improper placing of drains. Other factors which contribute to the problem are the practice of short-period tenancy, which gives the proprietor little interest in conserving the fertility of his land, and the system of renting land for the production of one type of crop only. Some fundamental changes in the current agricultural practices will be needed if further loss of valuable soil is to be prevented.

—Extract from *Nature,* 25th February, 1939.

(*Note.*—In East Africa it is generally reckoned that sweet potatoes do not encourage erosion. We may have to alter our ideas!—L.A.E.)

THE QUALITY OF COFFEE

A STUDY OF THE EFFECTS OF POLLUTED FACTORY WATER AND THE PRESENCE OF DAMAGED BEANS ON COFFEE QUALITY

By G. H. Gethin Jones, M.Sc., Soil Chemist, Department of Agriculture, Kenya Colony

Opinion has been divided as to whether the unavoidable use of a polluted water supply in the factory has any effect on the resulting quality of the coffee. From the evidence available it could not be said that the use of stream water containing varying amounts of fermenting-tank effluents, pulp-carrying water and possibly seepage from old pulp heaps always resulted in inferior quality or taint in the coffee; many down-stream estates, in fact, produce untainted coffee. This investigation was therefore arranged to find out definitely what was the effect, if any, of using polluted water supplies in the factory preparation of coffee. In later trials special attention was paid to the role of damaged beans in samples of coffee prepared by various methods.

Trial I

This first trial was arranged to find out whether the use of water containing fermenting-tank effluent had any effect on coffee liquor. As it was surmised that the condition of the effluent might have some effect, diluted effluent of increasing staleness was used. Good coffee, free from any Antestia damage, was used. This coffee was fermented under water, the treatments being with local fermenting-tank effluent, one, three, six and nine days old, diluted with nine parts of clean watetr, i.e. 10 per cent effluent solutions such as might obtain in certain local streams. In all cases freshly picked cherries were used for the series of treatments and for their corresponding controls, in which clean water was used. There were thus four treatments and four controls, which were later subdivided, giving a total of sixteen samples for liquoring, special attention being given to the presence or absence of any characteristic taints.

Liquoring Results

The eight samples of treated coffee were reported upon as clean with no characteristic taints, and seven out of the eight controls were given a similar report. The one remaining control sub-sample was reported as having a very slight taint. In this trial the addition of effluent of increasing staleness had had no significant effect.

Trial II

Coffee cherries from three different sources were each subdivided and given the following four different factory treatments:—

(*a*) Fermented under water with 10 per cent fresh fermenting-tank effluent.
(*b*) Fermented under water with 10 per cent 5-day-old foul fermenting-tank effluent.
(*c*) Fermented under water with 10 per cent sterilized 5-day-old fermenting-tank effluent.
(*d*) Fermented under water with clean water.

The sterilized foul effluent (boiled and cooled) was used to test whether any adverse effect that might result from adding foul effluent was due to biological action or to simple absorption of taint. These four treatments were each replicated with the three lots of coffee from different sources, thus giving twelve samples. The latter were subdivided into four sub-samples, giving a total of 48 units of coffee for liquoring purposes. Half the samples, i.e. two sub-samples out of the four in each case, were liquored immediately and the remainder were put aside for later liquoring.

First Liquoring Results

Two sub-samples out of six, representing treatment with 10 per cent five-day-old effluent, were reported upon as "very slightly tainted" and "slightly sour" respectively. These represented single sub-samples from each of two sources. The remaining sub-samples of this treatment, together with those from the third source, were clean and not tainted. All other treatments, represented by the remaining eighteen sub-samples, gave coffee which was reported upon as clean and without any taints. These liquoring reports again showed differences within sub-samples which suggested a possible variation in the composition of different sub-samples such as might be caused by the chance presence of taint-carrying beans. These results were not conclusive, except that they suggested the possibility that the use of foul effluent might induce taint under certain conditions.

Second Liquoring Results

Similar lots of coffee, comprising the remaining 24 sub-samples, were again liquored when old. This time four out of a possible six sub-samples, again representing the same treatment of coffee from the same two sources with diluted stale effluent, were reported as being tainted. The remaining two sub-samples of coffee from the third source were clean, as were twelve samples representing the two other treatments. This by itself would suggest that the presence of taints due to underwater fermentation with diluted effluent are apt to be more pronounced as the coffee ages. However, this second liquoring showed that three out of a possible six control sub-samples, prepared with clean water, had also developed a certain taint, and hence the above assumption had to be discarded. This work suggested that the use of foul effluents might produce taints in coffee and also that such taints might appear under clean conditions. This showed the need of more exact work with thorough hand-picking and the separate liquoring of different kinds of beans, some of which, such as damaged beans, might be the cause of introduced taints.

The first two trials had shown that it was difficult to introduce taints to order in high-grade coffee, but that tainted samples, often cutting across sub-samples, did appear without known reason, scattered throughout a batch. It was surmised that intrinsic differences in the small 4 oz. sub-samples liquored might be responsible for slightly different liquoring reports and more especially for the occasional appearance of taints. It was further surmised that certain unsuitable factory treatments might bring out or accentuate these taints.

In subsequent trials treatments were confined to the use of very foul effluents against clean water, and damaged beans were included in the mass of the coffee during preparation. The clean coffee was then carefully hand-picked and the different kinds of bean liquored separately.

TRIAL III

Very foul effluent, consisting of stale washing water, to which some fluid seeping from an old pulp heap had been added, was used. This mixture, which had a marked rancid-putrid smell, was used to pulp the coffee and the beans were allowed to ferment in it. After underwater fermentation was complete, more of the same fluid was used to "wash" the beans, foul effluent being allowed to dry on the parchment coffee without further washing with clean water. Thus every effort was made to induce adverse liquor by foul factory preparation. The control treatment was the use of clean water throughout. With one lot of both treatments some of the beans were deliberately damaged by a too close setting of the pulper. Later it was found that there

were many pulper-damaged beans caused by normal pulping and that there were some Antestia-damaged beans in all lots. The four lots of different arranged treatments were therefore nearer to duplicate treatments of foul and clean preparation. During the early stages of drying the maltreated parchment coffee had a distinct foul smell, but this gradually disappeared so that when dry there was only a suspicion of an unclean smell. Portions of each of the four lots of hulled coffee were well mixed and divided into three subsamples, without any selection, for the first bulk liquoring tests. The major portions of each lot were set aside for hand picking into different kinds of beans for the second liquoring.

First Liquoring Results

Each of the four ungraded lots was divided into three sub-samples for liquoring. Of the six sub-samples representing clean preparation, three were reported as clean and three as "slightly fruity". The six sub-samples representing "foul" treatment were all given adverse liquoring reports. A group of three sub-samples representing one lot of coffee were all reported to be "foul with taint," the other three sub-samples being referred to as having "slight taint," "suspicion of taint," and "fruity liquor" respectively. This first liquoring of ungraded samples of coffee which contained damaged beans showed that very foul under-water fermentation, followed by washing with the same fluid, tended to result in adverse liquor, but with variation within certain sub-samples. On the other hand, some control samples of coffee prepared under clean conditions were also reported to be "slightly fruity." Once more it appeared that some unknown factor tended to alter the liquor of certain sub-samples but not others, though great care was taken when mixing and subdividing the main samples.

In the second more detailed liquoring tests with the major portion of the coffees of this trial, very careful hand-picking into different kinds of beans was instituted. All four lots were divided into whole beans, triage, huller-damaged beans, pulper-damaged beans, and Antestia-damaged beans. It was not possible to separate all the pulper- and Antestia-damaged beans respectively into their own classes, hence these will be termed "mainly pulper-damaged" and "mainly Antestia-damaged." There were three sub-samples of whole beans, two of huller-damaged beans, and only one each, owing to scarcity, of the remaining three groups. These separate liquoring tests were arranged in an attempt to find out the type of bean mainly responsible for inducing taints. There were therefore eight separate samples of each of the four treatments, giving 32 sub-samples for liquoring purposes. Great care was taken by the liquorer with these second more detailed tests, which were carried out two months after the ungraded samples had been done.

Second Liquoring Results

After a series of inconclusive results with the previous trials, these tests gave some remarkable results. It was shown that whole undamaged beans, though prepared under foul conditions, invariably gave a clean liquor without any suspicion of taints, and that "foul," "unclean," and "tainted" liquors were confined to damaged beans only. All six sub-samples of such raw beans were described as clean, bold and nice, with qualifying remarks of duller colour and brownish tinge for some of the samples; the "roasts" were described as fairly bright to dullish and with brown centre cuts, whereas the cups were described as "clean, without taints, though rather strong." On the other hand, all samples representing "mainly pulper-damaged" and "mainly Antestia-damaged" were

given very adverse reports. The raw beans were reported to have "unclean to foul" smell; the roasts were dull with dirty centre-cuts, and in all cases the cups were described as either "tainted," "unclean" or "foul." The reports for triage and "mainly huller-damaged" coffee were more variable, and approached the damaged beans in general quality. It is likely that some pulper-damaged beans would be included in these lots.

In the case of clean water treatment, the whole raw beans were described as clean and of a nice colour, the roasts were described as of a "bright nice type" and the cups were described as "good to fine" and very nice. The damaged beans were described as having a clean smell, and a "fairly bright to dullish" roast, and the liquor was described as clean, though some samples had a strongish flavour, thus differing in quality from damaged beans prepared under foul factory conditions. The triage and huller-damaged beans were again more variable and tended to have strongish flavours.

These second liquoring results of sorted coffee beans showed that with foul preparation whole undamaged beans were not greatly inferior to similar beans prepared under clean conditions, whereas damaged beans acquired a very adverse liquor only under foul conditions of preparation. With clean conditions, samples of coffee made up entirely of damaged beans had a clean smell in the raw and clean though rather strongish liquor.

Third Liquoring Results

Some of the remaining sub-samples of the second liquoring were bulked and put aside for another two months, so as to check up the liquoring reports. Four composite samples, representing two of whole beans prepared under foul conditions and two of whole beans prepared under clean conditions, were again all reported upon as being "good clean raws," "good type of roast," and with "clean, very nice liquor." A single composite sample of damaged beans prepared under foul conditions was again reported upon as foul, whereas similar beans prepared in clean water were now reported as having a "common" liquor.

This work showed that when mixed ungraded samples, which carried taints following foul preparation, were hand-picked into "whole" and "damaged" beans and again liquored, the taints were confined to the damaged beans only, whereas the remaining whole beans gave a clean liquor. This suggested that foul preparation imparted taints only to beans which have had their outer protective tissues damaged by insects or mechanically by the pulper. The inclusion of these damaged beans with whole beans in a mixed sample had caused the whole lot to be tainted. Variations in sub-samples in the previous trials had probably been due to the chance presence or absence of damaged beans, which were carrying taints.

TRIAL IV

This trial was similar to the previous one, using foul and clean preparations respectively under conditions of dry fermentation. There were two lots of controls and two receiving foul treatments. In the latter case the pulping was done with this fluid and three lots of it were allowed to percolate through the coffee beans, which were then allowed to "dry ferment". All samples were allowed to over-ferment slightly, and the treated pair was then washed with this foul effluent without further cleaner washing. Again, the wet parchment had a foul smell which gradually disappeared as it dried. When dry the parchment coffee was hulled and the clean coffee divided into three kinds, namely "larger, whole beans," "smaller, whole beans," and "all damaged beans,"

for liquoring purposes. There were four sub-samples of larger whole beans (A grade only), two sub-samples of smaller whole beans and two sub-samples of damaged beans—mainly pulper-damaged, but containing some huller- and Antestia-damaged beans. This gave a total of 32 sub-samples for liquoring purposes.

Liquoring Results

All eight sub-samples of A grade whole beans prepared under foul, dry-fermentation conditions were given adverse liquoring reports for raw, roast and cup. The raws were described as "brownish to brown" and with "tendency to foxyness to rather foxy." The roasts were described as "inclined to brownness," and the cups as "fruity" for five samples, "tainted" for two samples, and "foul with sourness" for the eighth sample. Of the four sub-samples of the smaller whole beans, two were "tainted" and two "slightly fruity." The damaged beans were described as "tainted" for two and "foul" for the remaining two. Thus with foul dry fermentation all 16 sub-samples were described as either "foul," "fruity," or "tainted."

When similar samples of coffee were prepared under clean conditions, varying results were obtained for the two lots of coffee. In one case all six sub-samples of undamaged beans, including the two of smaller size, were described as "fairly full bodied and clean" and the two damaged samples as "tainted."

In the case of the second lot, five sub-samples of the undamaged beans were described as "medium to full bodied with very slight taint" and the sixth as "unclean." The samples of damaged beans of this lot were both described as "badly tainted."

Thus parallel trials with clean water, using separate lots of similar previously mixed coffee cherry, gave somewhat varying results with the dry-fermentation method of preparation. In one case damaged beans only were tainted, whereas with the duplicate lot the undamaged samples were reported to be "very slightly tainted" and the damaged beans as "badly tainted." These results are therefore not conclusive, though they do suggest that foul treatment had produced an inferior coffee.

Insufficient work has been carried out to warrant definite conclusions, but this preliminary investigation enables tentative comments to be offered for the benefit of coffee planters who depend on polluted water supplies for factory purposes:—

(1) Under conditions of polluted water supplies the general quality of coffee is inferior and it is more apt to be tainted. Hence the need of co-operative efforts to reduce stream pollution.

(2) Certain coffee taints which greatly lower the liquoring value of coffee are largely due to the presence of damaged beans which convey such taints to the whole sample.

(3) Damaged beans are more likely to convey taints when the coffee has been prepared with polluted water supplies.

(4) With clean water supplies, the presence of damaged beans is less likely to bring about taints under conditions of under-water fermentation.

(5) This work stresses the importance of efficient pulping with accurately set pulpers, so as to avoid as far as possible the nipping and bruising of the beans.

(6) It also stresses the necessity for efficient separation of newly pulped "lights" into a different fermenting tank so as to exclude faulty beans at this early stage, and again their further removal by thorough water-grading of the clean parchment coffee. Similarly, final grading at the coffee curing works, so as to remove all damaged beans that may have acquired taints due to faulty factory preparation, must be thorough.

Once more the writer gratefully acknowledges the co-operation of Mr. A. M. Pratt in all factory work, and of Mr. Devonshire for carrying out detailed liquoring tests on 136 samples of coffee.

A PRELIMINARY NOTE ON THE "WOODINESS" DISEASE OF PASSION FRUIT IN KENYA

By R. M. Nattrass, B.Sc., Dip. Agric. (Wye), Ph.D. (Lond.), Senior Plant Pathologist, Department of Agriculture, Kenya Colony

As a garden or ornamental plant, passion fruit (*Passiflora edulis*) has been grown in Kenya for a number of years, but large-scale cultivation for the manufacture of juice is a comparatively recent development. It was first planted on a commercial scale in Trans Nzoia in 1933 and in Sotik a few months later. The area devoted to this crop has since been considerably extended and is now approximately 1,000 acres, the chief districts being Trans Nzoia, Sotik, and, to a lesser extent, the neighbourhood of Nakuru.

The "woodiness" disease appears to have attracted attention early in the life of the industry. "Small leaf" was responsible for some loss in Trans Nzoia as easly as 1935. In the Annual Report of the Department of Agriculture for 1936 [1] "woodiness" is recorded as a new plant disease for Kenya and its virus nature is indicated. Early in 1938 Dr. Storey, of the East African Agricultural Research Station, Amani, visited the Colony and obtained material from Trans Nzoia with which he subsequently proved that the disease was caused by a virus which could, under certain conditions, be transmitted by pruning and handling with contaminated hands and knives.

In Trans Nzoia the disease has spread extensively and has now assumed alarming proportions. How the disease originated is not known, but it has possibly always existed on some wild host and passed thence to the cultivated passion fruit. It is unlikely that mechanical transmission carries the disease beyond the confines of a single plantation, but there may have been a certain amount of movement of diseased planting material within the Colony. As it has appeared suddenly in plantations often considerable distances apart, it is assumed that an insect vector exists, though no likely insect has yet been found on the crop in this country. A similar disease has been in existence for many years in Australia [2], where it has recently been proved by Noble [3] to be transmitted by certain species of aphids. It is likely that these insects will eventually be proved to be the vectors here.

With the information at present available certain recommendations for the direct control of the disease are given below. In view, however, of the virulence of the disease and the rapidity with which it can become established in a plantation, there is some doubt if it can ever be completely eradicated by such measures. It is believed that the complete control of the disease is most likely to be achieved by the finding or production of resistant varieties. With this aim, and in order to carry out a detailed study of the disease as it occurs in Kenya, a plan of long range research has been adopted by the Kenya Department of Agriculture and the East African Agricultural Research Station, Amani, working in co-operation.

The plan consists essentially of obtaining as many different species and types of *Passiflora* as possible from all parts of the world and testing these for resistance, first under laboratory conditions and later in the field. If any species or types are found to be resistant attempts will then be made to hybridize them with the cultivated *Passiflora edulis*, in the hope of

eventually obtaining a hybrid resistant to the disease and at the same time of commercial value for juice production. Meanwhile search is being maintained among existing plantations in the Colony for any plants which appear to be resistant to the disease in the field. Growers of passion fruit have been asked to co-operate in this search and to report to the Department of Agriculture the occurrence of any plants that appear to show resistance. These, if found, will be similarly tested in laboratory and field.

More recently, in the Sotik district, a disease has appeared which causes severe "woody" symptoms in the fruit but little effect on the foliage. The nature of this disease has not yet been determined, and attempts to transmit this form of "woodiness" by inoculation have so far failed.

It seems clear that in Kenya more than one strain of the virus exists or that the manifestations of a single strain differ considerably according to environmental conditions. A detailed study of this aspect of the problem is now in progress under the co-operative research scheme referred to above.

The following note refers exclusively to the disease as it occurs in Trans Nzoia:

The "woodiness" disease of passion fruit is so called on account of the characteristic effect which the disease has on the structure of the fruit, typical affected fruits being misshapen with a much thickened woody pericarp and reduced pulp cavity. Fruit symptoms vary considerably, according to the state of development of the fruit when the disease takes effect. Other factors, such as differ takes effect. Other factors, such as different strains of the virus and environmental conditions, which are under investigation, may also cause variation in the symptoms.

The fruit may develop to the normal size, the only external sign of the disease being an uneven coloration with the purple areas marked with a series of small green rings or flecks. Such fruits on being cut open may show very small areas of thickened and hardened tissue embedded in the pericarp.

Fruit approaching maturity may be slightly abnormal in shape and can be felt to have one or more hard patches which offer considerable resistance to cutting and which, in section, show a slight uneven thickening of the pericarp with small areas of hard glassy tissue embedded in it. Affected at an early stage of development the fruit may be considerably misshapen, with one or more pronounced swellings or protuberances, which are frequently of a lighter green than the surrounding surface. The hard thickened areas of the pericarp of these fruits correspond in position with the protuberances. As the "woody" tissue is incapable of further expansion, cracking and even splitting of the pericarp may occur. In the final stages of the disease small almost spherical fruits are formed, the pericarp of which is so thickened that the internal cavity has almost entirely disappeared.

Foliage symptoms are also varied and appear to be considerably modified by, and to some extent simulated by effects purely due to, environmental conditions. This variation occurs to such an extent that identical symptoms on different plantations are rarely met with.

The earliest obvious symptom on a strongly growing plant, which appears otherwise normal, is that some of the latest formed leaves appear slightly paler green than is normal. There is a suggestion of "bunchiness" of the leaves and a tendency for the shoot to turn abruptly upwards, almost at right angles, at the apex. This turning up, which appears to

be characteristic, is more marked and nearer the apex of the shoot than the natural turn up which normally occurs to same extent on the hanging shoots. Close examination will reveal a slight mottling or mosaic of dark and lighter green areas, with a tendency for the darker areas to be concentrated on either side of the mid-rib, so that the leaves tend to be lighter in colour towards the edges. These leaves do not continue to develop normally, but remain somewhat stunted and the mottling becomes more pronounced. A certain degree of puckering or blistering of the leaf tissue may occur as the leaves become older and there is considerable shortening of the internodes of droppers and side shoots.

In an advanced stage of the disease the whole plant takes on a yellow or chlorotic appearance and normal active growth ceases. All fruits produced have severe "woody" symptoms and fail to reach maturity. There may be considerable leaf fall with renewed lateral growth. These side shoots are stunted and, as the internodes of the stem are already shortened, there is a crowding together. Further leaf fall may occur, with later fresh growth of still smaller crowded shoots. In this advanced stage the whole vine has a bushy, spindly appearance with chlorotic foliage and a number of short almost leafless lateral shoots, with stunted apical leaves which usually show distinct mottling and some degree of distortion.

On seedlings the foliage symptoms are more pronounced. The first indication is usually a sharp curling downwards and inwards of the youngest leaves which a few days later develop a distinct mottling of the green colour in the form of fine dots or stipples of dark green. Such leaves later develop a more blotchy form of mottling and show considerable puckering and distortion. Subsequently formed leaves show similar symptoms and are much reduced in size, and further increase in growth almost ceases.

Direct measures of control at present recommended consist in the planting of disease-free material, the destruction of diseased plants and the avoidance of passing on the disease by handling and pruning. The disease is not known to be carried in the seed or in soil which has borne diseased plants, so that it is possible to start the establishment of a plantation with healthy material. Any subsequent infection must come from an outside source. It is strongly recommended that material for planting should be raised from seed on the farm in a nursery as far removed as possible from other passion fruit. It is particularly dangerous to propagate from cuttings or to introduce seedlings from other districts. The nursery must be kept under frequent observation, so that any diseased plants can be detected at once. It would be inadvisable to use any plants from a nursery in which the disease has appeared.

Successful control by the eradication of diseased plants hinges very largely on the ability of the grower to recognize the disease in the early stages. The earliest symptoms that are diagnostic occur before the fruit is affected and must be looked for on the youngest foliage. Plantations which are apparently healthy should be subjected to frequent inspections and any plants showing signs of the disease destroyed. Unless detected at an early stage, it is likely that the plants on either side will also be diseased.

It was at one time advised that the diseased plants should be cut off at ground level and allowed to dry out before removal, in order to prevent mechanical transmission of the disease through bruising and tearing of intermingled leaders. It is now considered

more expedient to cut off the plant at ground level and to burn or scorch immediately on the spot. By allowing the plant to wilt first there will be a danger of any possible insect vectors migrating thence to healthy plants. When healthy and diseased plants are entangled it would probably be best to cut off a length of the healthy leader without attempting to disentangle it, but this must be done with a disinfected knife before any part of the diseased plant is cut with it. In districts where the disease is known to occur the leaders should be stopped before meeting along the wires, so that suspected vines can be removed easily without danger to their neighbours. The roots may be removed at any time, provided that they are not allowed to produce shoots.

Caution must be exercised in replanting the gaps; it is of little value to put in healthy plants until it is quite certain that the disease no longer exists in the plantation. It must be borne in mind that a plant may be in a condition to infect its neighbours before the symptoms become noticeable. If, after destroying all diseased plants, no further sign of the disease appears after three months, it should be safe to replant.

When the plantation is fully diseased, all plants should be at once destroyed, as such a plantation will soon inevitably cease to be profitable and will be a source of danger to other plantations in the vicinity. There is no reason why the ground should not be replanted after a rest of two or three months, provided that care is taken to see that no roots, which might form ratoon plants, are left in the ground.

If the plantation is already considerably diseased it is doubtful if eradication will save the remainder. The plantation will continute to be decreasingly productive for some time, but it is likely that all will eventually become diseased. The question which confronts the owner is to decide whether to cut his loss and replant or to continue with diminishing returns. It must be borne in mind, however, that diseased plantations are a source of danger to the whole district, and the sooner they are eradicated the sooner will the disease throughout the country be brought under control. If this policy is adopted, individual plants should be destroyed as soon as they cease to produce saleable fruit.

Owing to the necessity of frequent pruning and of working the land, it is probable that spread of the disease in a plantation is largely brought about by the mechanical transmission of infected sap by means of contaminated hands and pruning knives. To avoid this as far as possible hands and knives of pruners should be sterilized by washing in soapy water or preferably in a disinfectant after pruning each vine. Pruners should also be warned not to touch any plants which appear in any way abnormal. These should be left alone for subsequent inspection.

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GELATINE GRUB ON TEA IN NYASALAND

By C. Smee, M.C., D.I.C., A.R.C.S., F.R.E.S., Government Entomologist, Nyasaland

In May, 1938, a serious outbreak of this insect (Limacodidae, *Niphadolepis alianta* Karsch.) was observed on two estates in Nyasaland. I was then in England and did not return to the Protectorate until the end of the year. Early in January, 1939, the insect was again recorded from the same two estates in very large numbers, and I then realized that in the previous year it had not been noticed until it had reached the peak of its infestation.

From the information obtained during 1938, however, and from the enormous number of grubs already present in January, 1939, it was obvious that a tea pest of serious destructive potentiality had developed, apparently rather suddenly.

The moth is indigenous to East Africa. Although the study of the pest has only been carried on for a few months, an early account of its occurrence in Nyasaland, with such information as is at present available concerning its bionomics, may be of value in placing tea planters and entomologists on their guard against similar outbreaks in other African tea areas.

Nyasaland Tea Districts and Historical Notes

In order that a clear picture of the status of this insect as a pest, at present, may be obtained, it is necessary briefly to explain that the tea-growing areas of Nyasaland are confined to two districts, Mlanje and Cholo. Both lie approximately on latitude 16° S. and between longitude 35° and 36° E.

Mlanje, which is much the older-established tea-producing district of the two, is situated on the south-east slopes of Mlanje Mountain at an elevation of 2,000 to 2,500 feet. It has an average rainfall of 70 to 80 inches, though 100 inches are not unknown. The Cholo area, some 30 miles to the west, covers a more extensive country at an altitude of about 3,000 to 3,500 feet, and has a rainfall of only 50 to 60 inches; some estates at times record less than 50 inches.

The original cultivation by Europeans in both these areas was coffee, from which crop *Niphadolepis* has been recorded in most East African territories, but never, as far as I am aware, in large numbers. In the Mlanje area the cultivation of tea appears to have followed directly on that of coffee, and this area has had a considerable acreage under this crop for the past thirty years. In Cholo, on the other hand, except for one estate which started in tea about 1908, the tea plantations are of comparatively recent date, mostly less than ten years old; tobacco cultivation has largely filled the interim since the old "coffee days".

It is only on two estates in the Cholo area, one of them being the plantation started in 1908, that *Niphadolepis* has now appeared in vast numbers, yet it can be found by careful search in all the other plantations both in Cholo and Mlanje. These two estates are reasonably adjacent to one another, the shortest straight distance between them being about three miles, but other estates even closer to each of them, in one case with only a road as a separating boundary, have remained practically free of the insect up to the present.

The first specimen of this insect that I found was a single larva, on tea in Mlanje, in March, 1926; it was bred up to the adult stage.

In March, 1930, two more larvæ were found on coffee in a plantation more than 100 miles north of the tea districts, and bred up. In succeeding years a few single specimens of the grubs were noticed from time to time on tea and coffee, but mainly on the latter crop. In 1930, correspondence was carried on with the entomological section of the Tea Research Institute of Ceylon on the subject of Tortrix and Nettle Grubs, and the information therefrom seemed to indicate that dissimilarity of conditions might preclude similar insects from becoming pests in Nyasaland. Moreover, perusal of the comprehensive papers dealing with Nettle Grubs and Gelatine Grubs, by G. D. Austin in *The Tea Quarterly*, November, 1931, February and May, 1932, and by J. C. Hutson in *The Tropical Agriculturist*, April and May, 1932, showed that the Gelatine Grubs known in Ceylon, particularly *Belippa laleana* Mo., which appeared to be most comparable to *Niphadolepis alianta* Karsch., seemed to be of relatively minor importance.

When therefore in May, 1936, the manager of the 1908-established tea estate in Cholo submitted a single larva of *Niphadolepis*, with the report that about twenty had been found on one bush but that no other bushes nearby appeared to be affected, I unfortunately expressed the opinion that it would be unlikely to become a serious pest. The much more common nettle grub, *Parasa vivida* Wlk., known from a wide variety of plants, had not then been recorded from tea.

Life History and Habits

Eggs.—Gistening white, scale-like, may show iridescence. Laid singly on both surfaces of the leaves. On hatching, the shell collapses and remains as a transparent white flat speck on the leaf.

Larvæ.—When first hatched the minute larva has some slight reddish-brown coloration and a few fleshy, dorsal, lateral and marginal protuberances. After a short time, not accurately known, the larva loses these protuberances and assumes a dull white colour with some darker dorsal markings. It is not known if this is accomplished after a moult or not; as the cast skins consist merely of a smear of white threads the moults are difficult to trace, particularly in the early stages, and it is possible that the skins are rapidly devoured, as occurs with nettle grubs. Growth in these early stages, however, seems to be rather slow, though there is considerable variation in the rates of development of larvæ of apparently the same age. Some larvæ about eighteen days old had only reached a length of 2 mm., while other at twenty days varied between 3.75 and 10 mm. in length.

The general colour of the very small specimens is dull white, with a rectangular sepia-coloured saddle situated mid-dorsally and a pair of darker coloured spots immediately posterior to this; an ill-defined light sepia curved band crosses the dorsum just clear of the anterior and posterior margins. There are very faint indications of sepia colouring in between these bands giving an impression of segmentation, but under magnification the darker markings appear to be situated underneath the integument, which is really white and faintly pitted.

At a slightly later stage the saddle disappears, but the pair of dark spots and the anterior band remain distinct. The posterior band becomes very faint or showing in the mid-dorsal area only. Underneath the integument, lateral of the mid-dorsal line, there appear two waved white lines connected across with one another by white lines at regular intervals, and extending from the anterior to the posterior dark bands. The larva may have a faint blue tinge all over.

NIPHADOLEPIS ALIANTA KARSCH.

EXPLANATION OF PLATE

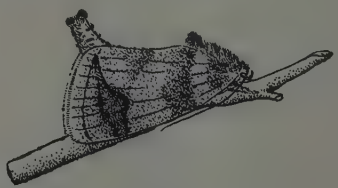
1. Young, slow developing grub, 18 days old. Length, 2 mm. Dull white ground colour with sepia saddle and faint bands, and pair of jet black spots.

2. Older, quick developing grub, 20 days old. Length, 10 mm. Pale blue or blue-green colour all over except for longitudinal white lines and irregular areas speckled white.

3. Side view of Fig. 2. Length, 10 mm.; height, 3 mm.

4. Side view of grub immediately prior to spinning the cocoon. Length, 12.5 mm.; height, 5.5 mm. Colour white or pinkish-white.

5. Cocoon in fold of leaf, covered with white silk webbing.



6. Adult moth in resting position on shoot; abdomen turned up between wings.

7. Adult moth. Colour golden brown all over with a few irregular darker areas on fore-wings only. Expanse, 23 mm.

Larvæ of 4 to 6 mm. in length, which may represent a month's growth, have lost all the dark markings and have assumed the typical blue to blue-green colour with distinct white lines, as mentioned, which remains characteristic for the rest of the larval life until immediately before pupation.

Older larvæ show also some faint patches of white speckling on the surface of the integument and faint indications of segmentation at the margins of the posterior two-thirds of the body.

It has been remarked that the rate of development of the larvæ is very variable, but sixty days and over have been recorded in the laboratory for the slower developing individuals, and it seems possible that there may be seasonal influence of this factor.

Pupation and Cocoons.—Full grown larvæ, which may measure from 10 to 16 mm., probably according to sex, become entirely white or pinkish-white in colour some twenty-four hours before spinning the cocoon. This change does not appear to be connected with a moult, as far as I have observed. The larvæ also shrink somewhat in length and assume a noticeably hump-backed shape, sometimes with the posterior end turned up as well.

The cocoon is typically Limacodid, and is spun between two leaves, or attached to a single leaf, by a web of white silk that masks its natural brown colour. Cocoons vary in length from 6 to 12 mm.; the smaller ones usually contain male moths.

In the field, when the insects are few in numbers or in the early stages of the serious infestation under discussion, cocoons are always attached to the foliage of the tea bushes. But in May, 1938, it was recorded that pupation was taking place largely on the ground at the base of the bushes, and that the migration of the full grown larvæ downwards was very noticeable. The same phenomenon has occurred this year (1939) at about the same time. It is not known whether this is due to climatic influence, viz. the onset of the cold season, or simply due to overcrowded conditions on the affected tea bushes which may, by this time, be carrying well over a hundred larvæ per bush.

The duration of the cocoon stage is, like the larval life, very variable, and there is a strong diapause factor occurring in the life-history of this insect, apparently connected with seasonal conditions.

The single specimens that I bred in March–May, 1926 and 1930, had pupal periods of 22, 19 and 20 days respectively. Of 11 cocoons formed in January, 1939, by grubs from the infested tea area, the longest period was 21 days. Of six cocoons from the same area, formed in February, 1939, one hatched in 19 days, three in 20, one in 24 and one in 34 days. However, of a number of cocoons from the same area formed in April, 1939, none have hatched at the time of writing, the oldest being 43 days old. In the 1938 outbreak, when observations commenced in May of that year, the first moth hatched 107 days after the formation of the cocoon, and from nine cocoons formed in July, 1938, two females emerged on 26th January and 7th February, 1939, periods of over 179 and 191 days respectively, though the remaining seven did not hatch at all. (See under "Parasites and Diseases.")

The phenomenon appears to be common among the Limacodidae, and pupal periods of 206 and 227 days have been recorded for *Parasa vivida* Wlk. in Nyasaland.

Adult.—The moth is described and figured in Seitz' *Macrolepidoptera of the World,* Vol. XIV; text p. 468, Plate 75 (c). (In the writer's copy the names *improba*

and *alianta* have been transposed in the plate.) Moths may occasionally be seen in the field, either at rest on the outside of the bushes or flighting quickly and jerkily for short distances. Copulation has been obsesrved on two occasions, taking place at mid-day during slight rain, the female hanging by the forelegs to a leaf at the outside of a bush and the male hanging head downwards from her.

Larval Feeding.—In the early stages the larval feeding marks are reasonably distinct, and after a little practice an observer can easily pick out attacked bushes by walking quite rapidly along rows where the bottom, older leaves can be quickly scanned. The very small larvæ eat out minute, completely circular pits in the lower surface of these older leaves, which pits rapidly turn brown at the edges and at the upper epidermis, which is not usually penetrated. The appearance of the upper surface of these leaves is thus as though a fungoid disease had attacked them, and as the larvæ move about quite considerably and at a greater pace than their slug-like form would lead one to expect, a very distinct "spotting" of a number of leaves by only a few larvæ is the result. Where the insect is present in only small numbers, these attacked leaves are more easily noticed than the larvæ themselves. Later the areas eaten out take on a more irregular shape, but usually, on tea at any rate, without penetrating the upper epidermis, and when half-grown the larvæ are capable of feeding on the edges of the leaves and thus consume them entirely.

It is perhaps necessary to point out that other Limacodid larvæ may, in the young stages, feed in a rather similar manner, but my experience, so far, is that they generally make larger and more irregular shaped areas, and begin feeding on the leaf edge sooner than in the case of *Niphadolepis* larvæ.

The alga, *Cephaleuros mycoidea,* has been found growing round the edge of the old, small pits in a complete circle, giving the impression of their being "disease" spots and nothing else.

Number of Broods.—The variable rate of growth of the larvæ and the diapause in the pre-pupal stage quite obscures any regularity in the breeding of this insect. As early as January, 1939, all stages were to be found without difficulty, and the position appears to remain the same for nearly six months. Observations at the end of the dry season and at the break of the rains, September to October and November to December under local conditions, have not yet been possible, but it is quite apparent that the insect begins to increase rapidly in numbers at a much earlier period in the tea-flushing season than has been noted.

Damage

It must be pointed out that it would be difficult to state whether the affected plantations have, in the two seasons under review, lost any appreciable quantity of flush from the attack of this insect, though at the height of the infestation young foliage is certainly being destroyed.

In the early stages of the outbreak each year the hard, bottom leaves of the bushes were attacked, and normally this type of leaf would seem to be the favoured food. But the destruction of this supply forces the grubs to feed higher and higher up the bushes, and from sheer weight of numbers the final result is almost complete defoliation. In 1938 this situation was not reached until late in May, when under local conditions the tea flush is nearly at a standstill. This year (1939) the attack, in general, appears to have been slightly earlier. Naturally, any continuance of earliness in the infestation brings the main flush into danger, as the grubs do not refuse the tender foliage if nothing

else is available. Whether this will come about remains to be seen, but there is a very definite secondary action arising from the defoliation of the bushes which must in the long run be detrimental to them and of which there has already been indication. The defoliation stimulates growth of new foliage from buds at the summit of the bushes, although at this time of the year, the beginning of the cold season, the bushes are normally in a more or less quiescent state and the regular pruning cycle is about to commence.

In small areas, immediate pruning could be undertaken, and this out-of-season activity on the part of the plant could be checked without delay. But with a heavy infestation covering most of a plantation, a very considerable amount of new growth can be made before the proper pruning can be executed, and the bushes concerned will thus receive a serious check after they have drawn for some time on their reserve root supply of food to make good the effect of the defoliation accomplished by the insect. It was, in fact, quite noticeable after the 1938 attack that bushes which had perforce been subject to such treatment were much slower in breaking away the following season than normally, and did not produce a really full cover of foliage for a very considerable time. As far as these bushes were concerned, then, the flushing period for 1939 was considerably curtailed.

Repetition of the process year after year, on increasing areas, might lead to considerable loss of flush.

The potentialities of the pest in causing loss of flush, directly by feeding on it or indirectly by upsetting the normal growth of the tea plant, cannot therefore be ignored.

Alternate Host Plants

Various plants, other than tea and coffee, have been found with larvæ of *Niphadolepis* on them, but several of these have been in the vicinity of infected tea, and it is as yet uncertain if they can be classified strictly as alternate host plants.

Castor oil is undoubtedly a widely distributed host, as the writer has obtained larvæ from this plant growing on the lake shore at Domira Bay, at an altitude of 1,650 feet and some 300 miles away from any tea, as well as in many other places including the tea districts.

Aleurites montana, various fruit trees, particularly apples and plums, and probably roses, can be accepted as definite hosts.

The following have all been found, in the vicinity of infected tea, to be carrying larvæ: Peaches, lemon, *Datura* sp., custard apples, *Ficus* sp. (wild), *Pterocarpus angolensis,* and *Hibiscus* sp.

Parasites

Parasitism has been little in evidence, as is only to be expected. So far the writer has only bred up three specimens of a Chalcid and one Braconid (? *Rhogas* sp.) from second or third instar larvæ. In the period March–April, 1939, a Chrysid wasp appeared to be fairly numerous in the cocoons then to be found, but later it seemed to be much diminished in numbers. In one of the cocoons that were formed in July, 1938, and did not hatch (see above, under "Pupation"), a fully developed Tachinid in an open puparium, the cap of which was loose in the cocoon, was found. It seems unlikely that a Dipteron could force its way out of a Limacodid cocoon, but this may indicate that parasitism of the larvæ by Tachinids does take place.

Predators

The Pentatomid, *Macrorhaphis spurcata* Wlk., has several times been found feeding on half-grown larvæ. It is doubtful, however, if much check on the pest is exercised in this manner. In 1938, towards the peak of the infestation, crows appeared in large numbers and attacked the grubs and cocoons on the lower parts of the bushes and on the ground. In fact, it was the presence of these birds that drew attention that year to the insect!

Diseases

Similar outbreaks of insects, as is well-known, have sometimes been brought to a sudden end by diseases of various kinds. A very few, apparently, "diseased" larvæ have been seen in the field and an occasional one in captivity has died from unknown causes. Some cocoons, collected in the field, have contained shrivelled larvæ or apparently fungus-diseased pupæ or moths. Of the remaining six cocoons that were formed in July, 1939, and did not hatch (see above, under "Pupation" and "Parasites"), four contained shrivelled larvæ and a fungus, probably a *Mucor,* and two contained fully formed moths which were dead from no apparent cause. No ravaging disease seems to be evident at present therefore in Nyasaland.

Control Measures

On the occurrence of sudden outbreaks of this sort of any insect the entomologist is promptly asked to devise immediately methods for exterminating the pest, and, as every entomologist knows, it is a sheer impossibility to do so. In the case of pests of the tea crop, the first thought is usually whether pruning can be brought into effective play, so that by destruction of the prunings a check shall be put on the further development of the pest.

In 1938 some observations were made on the possibilities of using pruning as a control of the gelatine grub. It was found that the larvæ would continue to feed on withering prunings, lying on the ground, for as long as 26 days. This gave many of them ample time to complete their development and form cocoons, while others migrated to unpruned areas without difficulty. Therefore some method of destroying the prunings must be employed. It was proved experimentally that if prunings were suitably buried an almost complete mortality of larvæ occurred in about fourteen days, and any moths that hatched were unable to emerge through the soil. To obtain successful results, however, the prunings must be buried within a very short time of being cut, preferably the same day, and they must be buried in small quantities at a time under a reasonable covering of soil. A large bundle of prunings loosely packed into a hole would permit of further development of the grubs and emergence of moths.

On a widely and heavily infected estate one is at once confronted with practical difficulties in carrying out such work. An abnormally large labour force would be required under unremitting supervision. In well-established and well-grown tea the burying of prunings straight away is a matter of considerable difficulty; and there is the risk that the large amount of material of high carbohydrate content thus incorporated in the soil might become infected with *Armillaria* where this root disease is present.

Removal of the prunings and destruction of them by fire, while avoiding some of these difficulties, necessitates an amount of labour, in order to get the work done quickly enough to be of any value, that would not generally be available, and still the ground under the bushes would have to be cleared of larvæ and cocoons.

It is obvious that such methods are applicable only to small, confined areas of attack, as also are any spraying measures, the difficulties of which in connexion with tea need not be enumerated here.

The question therefore becomes one of how to prevent an infestation from starting, and the only possible solution appears to be *the regular employment of hand-collecting gangs as an essential part of tea estate management.*

Anyone reading the Ceylon papers referred to above must be struck by the fact that many of the caterpillar pests of tea in that country seem to be of comparatively recent development as pests, though individual specimens have been recorded from the crop from time to time over many years. The deduction is that had systematic and continual collection been practised in the past the present outbreaks could probably have been avoided.

It seems clear that if regular hand-collecting gangs had been employed, year by year, on the estates in the Cholo district the present infestation of the gelatine grub would have been prevented. Instead, a very large labour force will probably have to be employed on this work early in the season, when cultivation and removal of weeds should normally be the first consideration.

Cause of the Outbreak

In reviewing the possible reasons why this insect has, apparently in a season, appeared in colossal numbers in one tea district only, climatic records have been compared over a period of five to six years from the two infected estates in Cholo and two estates in Mlanje. Apart from the total annual rainfall, there do not seem to be outstanding differences.

The means of five years' records show that on the Mlanje estates there are 140 to 150 rainy days in the season, including 80 days having a fall of more than 0.25 of an inch. Similar records for the two Cholo estates show only 108 and 56 days in one case and 132 and 68 days in the other.

Another slight difference between the two areas occurs at the beginning of the rains in October–December. In most years the Mlanje estates experience less than 60 dry days during this three-month period, including over 12 days having half an inch or more of rain. For the Cholo estates the records show the reverse. In the Mlanje area also the maximum temperatures run considerably higher than at Cholo.

It is not known whether these factors have any effect on the insect or its parasites, and comparison of climatic records of the infested with non-infested estates in the Cholo area has still to be completed; but they have been mentioned as perhaps indicating conditions under which the insect thrives.

It may be significant that, in the six years' records studied, the widest divergence between the Mlanje and Cholo conditions in the October–December period occurred in each of the three seasons preceding the outbreak in Cholo in 1938.

From the Ceylon information already quoted the evidence points to the gradual development, over a considerable number of years, of Limacodidae in general, and shows that they have there become "spasmodic pests" in the *wetter* areas but "chronic infestations" in the *drier* areas.

In Nyasaland, the wetter of the two tea areas, Mlanje, has a less annual rainfall than the driest of the Ceylon areas. In Ceylon the forms of Limacodidæ that are gelatine grubs appear not to have become pests of importance. May it be that the drier conditions of the Nyasaland tea areas are conducive to the development of this type of insect?

But comparison of the climatic conditions in the two tea-growing areas of Nyasaland forces one to think that the reason for the outbreak of this insect in such a comparatively circumscribed area must be due to some other cause or influence. Again, the Ceylon information indicates that this type of leaf-eating caterpillar is always present in the tea plantations. As has already been stated, *Niphadolepis* has been recorded from tea and coffee in Nyasaland for many years past, and that it is indigenous to East Africa. It appears most likely therefore that the present outbreak in Nyasaland is due to the gradual numerical development of the insect over a number of years and not to any particular set of climatic conditions occurring in one area and not in the other, inducing a "sudden outbreak".

Summary

Gelatine grub appeared in vast numbers on two estates in one tea-growing area of Nyasaland in 1938 and again in 1939, resulting in almost complete defoliation of the bushes. It is known to be present in all the tea estates in the country as isolated individuals. Both local (China) and Indian jats are attacked, and it can be found on tea both under shade and without shade; the two infected estates, however, being without shade. Tea in any situation, on high ridges or in wet hollows, is equally infested.

I give a review of the information available up to May, 1939, in the hope that other tea-growing areas of East Africa may be able to forestall similar outbreaks.

The cause of this infestation is not known, but it seems most probable that the insect has developed numerically over a number of years, this development having been accelerated in recent years perhaps by some breakdown in natural control and certainly aided by the vast extension of a suitable food supply in the area concerned. The habit of the pest in feeding mainly on the under-surface of the lower leaves, particularly when present in small numbers, greatly assists it to escape detection, and I strongly urge that the regular employment of permanent insect collecting gangs should be adopted as an integral part of tea estate management.

I wish to acknowledge the valuable work on this pest carried out in 1938 by Mr. A. P. S. Forbes, B.Sc., A.I.C.T.A., Agricultural Officer in the Mlanje District, whose reports have been freely drawn upon.

THE CONSERVATION OF THE NITROGEN OF COTTON SEED

By G, ap Griffith, Ph.D., B.Sc, (Wales), A.I.C.T.A., A.I.C., Chemist, and P, Chandler, Plantation Manager, Department of Agriculture, Uganda

In seasons when the price is favourable a considerable proportion of the cotton seed produced in Uganda is exported as such. In districts remote from railhead export is rarely profitable, and again in years of low prices none except the most favourably situated ginneries can dispose of their seed at an economic price.

One of the obvious local uses of cotton seed is as fertilizer; this is not by any means its only possible use, but it is the one that will be considered in the present article.

The direct application of the seed to the land presents practical difficulties, chief among which are the facts that (*a*) control of seed issue for planting purposes would be difficult, and (*b*) the use of viable seed as fertilizer would greatly increase the incidence of cotton pests and diseases.

The use of seed that has been made non-viable without rotting, e.g. by heat treatment, has its dangers. It has been shown (Ann. Rpt. Dept. Agric., Uganda, 1937) that with quantities as low as four tons to the acre the initial rapid decomposition of the seed resulted in a considerable evolution of ammonia, rendering the land unsuitable for planting for some time and probably resulting in a heavy loss of nitrogen, though this latter point needs verification. Preliminary rotting of the seed is therefore necessary, but here also an evolution of ammonia is inevitable, with the grave objection that much of the ammonia will be dissipated.

The object of the present investigation was to estimate the extent of the loss of nitrogen due to this cause and also to determine whether the loss could be reduced by mixing the seed with less nitrogenous material.

Procedure

The experiment was carried out on a plot of land at the lakeside in the Botanic Gardens, Entebbe. The material available for mixing the seed was dry fallen leaves collected from the Gardens. Various proportions of seed to leaves were used (see Table II). The method used was to make four stacks of each mixture, each roughly three feet deep, sandwiching the seed and leaves and watering liberally as each stack was built. After the first month adjacent stacks were turned together in pairs, with liberal watering, thus making two larger stacks of each mixture. After the second month the resulting two stacks were turned together, with watering, to leave one stack of each mixture. This was left for the third month without disturbance and was then sampled for analysis. After a further period of a month, the heaps were sampled a second time. To obtain an estimate of the weight of material in the completed stack the latter was levelled off and a measured section cut away. This section was bagged and weighed and the total weight of the heap was thus computed. This was done for each sampling.

The results of the analysis are given in Table I, and in Table II are re-calculated to show the losses of nitrogen from the stacks.

TABLE I

Sample	1 Moisture	2 Loss on Ignition	3 Ammoniacal Nitrogen	4 Kjeldahl Nitrogen	5 Total Nitrogen 3+4	6 Organic Carbon (Loss on Ignition /1·72)	7 Ratio C/N
	Per cent	*Per cent*	*Per cent*	*Per cent*			
Undiluted seed :							
First sampling ..	47·5	94·3	0·91	4·00	4·91	54·2	13·6
Second sampling..	31·7	88·1	0·69	3·64	4·33	51·2	14·1
Mixture I :							
First sampling ..	57·5	72·7	0·63	2·84	3·47	42·2	14·8
Second sampling..	50·4	72·3	0·62	3·20	3·82	42·1	13·2
Mixture II :							
First sampling ..	51·4	72·4	0·43	2·35	2·78	42·0	17·9
Second sampling..	43·8	63·6	0·43	2·30	2·73	36·9	16·0
Mixture III :							
First sampling ..	50·9	65·9	0·21	2·03	2·24	38·3	18·9
Second sampling..	48·1	60·7	0·16	1·97	2·13	35·4	18·0
Original leaves ..	12·7	78·9	—	1·03	1·03	45·8	44·5
Original seed ..	10·7	95·2	—	4·51	4·51	55·3	12·3

NOTES.—Except for column 1, percentages are on oven-dry material.

The C/N ratios in column 7 are obtained by dividing the Organic Carbon figure by the Kjeldahl Nitrogen, *not* by the Total Nitrogen.

TABLE II

SHOWING THE LOSS OF NITROGEN FROM THE STACKS

Total Dry Weight in lb.			Total Nitrogen in lb.			Percentage Loss of Nitrogen	
Original	First Sampling	Second Sampling	Original	First Sampling	Second Sampling	First Sampling	Second Sampling
9,100 lb. cotton seed	4,710	5,050	410	231	219	*Per cent* 43·5	*Per cent* 46·5
3,480 lb. seed 1,590 lb. leaves	2,590	2,990	173·5	90	114	48·0	43·3
3,480 lb. seed 3,990 lb. leaves	5,740	5,360	198·3	159·5	138·5	24·5	28·6
2,150 lb. seed 3,990 lb. leaves	5,070	5,360	138·3	114	114	17·6	17·6

Discussion of Results

The loss of nitrogen from the cotton seed rotted alone and also from Mixture I is considerable and in practice would be even higher than is indicated, because probably much of the ammoniacal nitrogen would have disappeared in the course of application in the field. The nitrogen figures for Mixture I are unreliable owing to the difficulty of obtaining a fair sample with a mixture containing such a high proportion of cotton seed.

The loss of nitrogen is considerably less in Mixtures II and III. In future work more dilute mixtures of cotton seed will be used in order to see to what further extent the loss can be reduced. In the present experiment the saving of nitrogen is even greater than is indicated by the total nitrogen content, as the proportion of ammoniacal nitrogen is less. Decomposition is probably not complete in the heaps, but that it has gone a long way is indicated by the loss in total dry matter.

That there must be a considerable sampling error is shown by the fact that the estimated figures for total dry matter are in three cases higher in the second sampling than in the first. That the error lies in the water content of the sample is indicated by the fact that the figures for nitrogen and loss on ignition are less for the second sampling in each case except in Mixture I. There the high proportion of cotton seed and consequent heterogeneity of the heap made the taking of a fair sample impossible.

It is generally accepted that an organic material added to the soil should, to avoid either wastage of nitrogen or fixation of the soil nitrogen, have a carbon/nitrogen ratio nearly equal to that of the soil. It will be observed that unrotted cotton seed fulfils this condition, and it may be asked why such a large loss of nitrogen does in fact take place. The reason is that the individual cotton seed is not a homogeneous entity. First, there is the kernel, which contains most of the nitrogen of the seed; then the husk, which is one of the poorest in nitrogen of all plant materials; and thirdly, the "fuzz" or cotton lint remaining on the ginned seed, which is almost pure cellulose and non-nitrogenous. The fuzz disappears quickly when the seed is rotted and probably helps to fix some of the surplus nitrogen of the kernel, but the husk is extremely resistant to decomposition. Undecomposed husks may be found on land even two years after a dressing of cotton seed.

The husk therefore plays little part in the composting process and the kernel decomposes rapidly with a considerable loss of nitrogen. In Table I it will seen that the C/N ratio of the cotton seed has actually increased after the seed has rotted.

OUR PRIZE EUPHEMISM

"Where hippopotamus are numerous and reports show they are causing damage to cultivation they are dealt with departmentally. In less serious cases a system of low fences is used. Rhinoceros are at times a source of worry to the European planter as they trample down his young coffee trees. They also are dealt with departmentally."

—Game Warden, Tanganyika.

SOUTH AFRICAN GRASSLAND INVESTIGATIONS—I

By R. S. Ball, M.A., Dip. Agric. (Cantab.), A.I.C.T.A., Agricultural Officer, Kenya Colony

This article (in two parts) and a further one which will deal with field crops, forage crops, and animal husbandry, are based on information obtained during a visit to South Africa in February of this year. Much of the agricultural investigational work being undertaken at the experimental stations of the South African Department of Agriculture, particularly the work on grasslands, is applicable to Kenya, as climatic and other conditions are in many cases not dissimilar.

School of Agriculture, Potschefstroom

The work at this station consists largely of experiments on the management of natural grassland and grazing trials of various exotic and artificially established grasses. It is interesting to note that well-managed veldt is showing a stock-carrying capacity only 10 to 15 per cent lower than that of the established species, although it is still too early to tell definitely whether the veldt herbage will remain stable under such conditions of stocking. This is of considerable importance when the cost of establishing these exotic species is considered. The view generally prevails that in such an area, when rainfall is irregular and uncertain, the grazing period is not prolonged appreciably in these established pastures, and that too much stress has been laid on the possibility of making use of exotic species; also that too little attention has been paid to the conservation of fodder grown on the arable land. It is realized that only under exceptionally favourable conditions of soil and rainfall do these exotic grasses generally flourish (as at Cedara), and that in most parts of the Union their establishment even on a limited acreage may be difficult or impossible.

As these results are in some respects similar to those obtained in Kenya, the importance of fodder conservation is once again stressed. The chief grasses under trial in established pastures at Potschefstroom were various strains of Woolly Finger (*Digitaria* sp.) and Australian Rhodes grass. This latter grass has proved itself, as in Kenya, to be suited only to short-term leys, as its yields fall rapidly in the second year after establishment.

It is possible that some of the strains of Woolly Finger grass under trial in the Union would be worth trials in Kenya for the drier areas, such as Rongai. Although they made good growth, they did not form a complete grass cover in the paddocks, the sward, in fact, being little closer than that of well-managed veldt. The cost of establishment of these species has been found to be considerable, as thorough preliminary preparation of the land is necessary and two years are required before intensive grazing can be practised.

The experiments on the management of veldt grazing are of considerable interest since they emphasize the importance of resting Red Oat grass (*Themeda*) veldt and the need for control over such grazing in order to prevent deterioration of the herbage. Although conditions with regard to seasons are very different from those in Kenya, the resting and rotational grazing of oat grass might well be tried in experiments there. Experiments on burning are also included, whose results to date indicate that annual burning is deleterious to the herbage and that the exercise of proper control over the grazing will obviate the necessity for burning. Experiments have also been carried out on the effect of fertilizers on veldt grazing, with results somewhat similar to those in

Kenya, since the fertilizers produce little effect apart from a temporary stimulation of growth by phosphates and nitrogen.

SCHOOL OF AGRICULTURE, CEDARA

Kikuyu Grass (Pennisetum clandestinum)

It is interesting to note that exactly the same conditions are required at Cedara for the successful cultivation of this grass as in Kenya, i.e. a high humus content in the soil and high moisture conditions with a cool climate. It is unfortunate that the paddocks from which all the results have been obtained relating to the production of 1,000 gallons of milk per acre per annum appear to be situated on the site of an old pig run, and receive a considerable amount of soil and manure annually which is washed down during the rains from the farm buildings. In addition, annual dressings of 1,000 lb. of artificial fertilizers per acre are given. The Kikuyu grass pastures on the rest of the farm are not nearly so productive, in spite of the very heavy applications of fertilizers, owing to the lower humus status of the soils. Attempts are being made to introduce legumes into the Kikuyu grass herbage in order to reduce the amounts spent annually on fertilizers (nitrogenous), but it is doubtful whether it will be possible to establish these except in areas where the Kikuyu grass is least productive. It is found at Cedara, as in Kenya, that Kikuyu grass can be rejuvenated by ploughing and that good soil aeration will assist its growth for a year or two, even if the humus content of the soil is not high. Of leguminous plants, *Trifolium africanum* is the most promising, and this would be worth a trial under Kenya conditions if it has not already been tried. Experiments are being carried out on the inoculation of different types of clovers with bacteria and the toxicity of certain bacteria to various clovers has been demonstrated.

Other Grass Species

The outstanding established grass species at Cedara is *Paspalum dilatatum*, which is used for the provision of summer grazing. The soil conditions demanded by this grass are not nearly so exacting as those of Kikuyu grass, and it responds readily to artificial fertilizers, in particular nitrogen. In addition, it will probably be possible to establish leguminous plants in mixture and hence reduce the expenditure on purchased nitrogenous fertilizers. The carrying capacity and palatability of this herbage has shown itself to be high. Australian Rhodes grass has proved to be rather short-lived in these areas and is chiefly suitable, as in many areas in Kenya, as a short-term ley grass. *Paspalum* does not, however, provide winter grazing in South Africa, and for this reason trials are being made of mixtures of English and Australian grass species, such as *Phalaris tuberosa*, rye grasses and cocksfoot, which have proved successful. In addition, clovers have been included in these mixtures. It has been found that the clovers only grow satisfactorily where the humus content of the soil is high and generally speaking the cultivation of these exotic species of grass also demands very favourable soil conditions.

Actually, the best grazing of these species is to be found at Cedara on old drained swamp land. At Mr. Montague Simpson's farm at Nottingham Road there are exceptionally fine pastures established from these species, but again the paddocks are situated on alluvial deposits from a river bed, conditions with regard to soil fertility and moisture being exceptionally favourable. It has been found that seed of these species imported from New Zealand has generally given more satisfactory results than that imported from England.

Owing to the highly seasonal nature of the production of grass at Cedara, a condition further accentuated by the heavy applications of nitrogenous fertilizers, the problem of conservation of surplus grass is an important problem. Haymaking is frequently impossible during the flush periods on account of weather conditions, and large quantities of completely ruined hay were being used for the manufacture of compost. For this reason a considerable number of silage experiments have been carried out and silage of moderate quality has been made from both Kikuyu and Paspalum pastures. The addition of molasses has not proved beneficial. All the experiments have been carried out in concrete tower silos, no information being available as to the suitability of the various types, such as sisalkraft and pits, which have been tried in Kenya.

The animal husbandry officers are generally of the opinion that the grass silage was distinctly inferior in quality and palatability to the maize silage previously used, but it is considered that by more careful wilting before ensiling a better quality may be produced under higher temperature conditions.

Veldt Management Experiments

Experiments on veldt management were being carried out at Cedara on similar lines to those at Potschefstroom, the chief treatments being as follows:—

(1) Annual burning.
(2) No treatment.
(3) Burning during summer period.
(4) Burning at beginning of winter.
(5) Burning at end of winter.
(6) Mowing and light grazing.
(7) Burning in alternate years.

Results have shown that *Themeda triandra* will re-establish itself in the absence of grazing on veldt from which it has largely disappeared as a result of annual burning, while grazing of any intensity tends to destroy it, and grasses such as *Sporobolus* sp., *Aristida* sp., replace it. Where neither grazing nor burning is practised, a mat accumulates and the land tends to revert to bush. As these results are different from those obtained at Potschefstroom, it indicates the local nature of these veldt management problems and again emphasizes the need for the extension of work on similar lines in Kenya. It is believed at Cedara that this sour veldt can be improved by a combination of grazing, resting and natural seeding, and experiments to test this are now being designed.

Research Stations of the Union Department of Agriculture

Introduction of Grasses and Separation of Strains

Large collections of indigenous and exotic grasses are made and are planted out at stations such as Prinzhof and Rietondale. They are treated essentially as cultivated grasses and are heavily manured at Rietondale, where the soil is deficient in humus, but being of a loose and open nature is exceptionally favourable to the rapid spread of stoloniferous species. At Prinzhof the soil itself is deep and rich in humus. The result is that most of these grasses and strains are growing under very favourable conditions, which could often not be repeated on a large scale. The chief interest in this work lies in the selection of various strains and types, in particular of *Digitaria* sp. and *Panicum* sp. The diversity of habit of growth, leafiness, drought-resistance and other characters within these strains is most remarkable.

A collection of Kenya grasses has been established and a very large number of different types of *Cynodon* species have been isolated. As in Kenya, there is a paucity of leguminous plants which will

stand up even under these exceptionally favourable conditions, although *Vicia* species (*Cracca, sepium, tenuifolia*) and *Trifolium africanum* showed some promise at Prinzhof, but in general it was considered that as yet none are really suitable for inclusion in pasture mixtures on a large scale. It was interesting to note on these stations the effect of organic matter on the growth of Kikuyu grass; in the absence of organic matter, fertilizers had very little effect on the growth of this grass. Experience in Kenya is similar. With certain other grass species, fertilizers applied over a period of years in the absence of humus had produced an actually depressing effect on the yields of grass. It is interesting to note that at Rietondale, where the soil is sandy and low in humus, insufficient compost can be made on the station for its requirements and it has to be brought from an old station, now closed down, which is used solely for the purpose of running cattle for the manufacture of compost. This is a matter of considerable practical importance when the establishment of these artificial pastures on a farming scale is considered, and it serves to show that their establishment can generally be only over small areas in ordinary farming practice, and that the problem of veldt management is of the most vital importance, since it is from this that the bulk of the grazing must be obtained. The value of the complete collection of types and strains lies in the fact that it enables comparative trials to be made and supplies of seed and planting material of pure strains to be built up for issue to farmers who wish to establish artificial pastures.

An outstanding grass from these collections was Makarikari *Panicum*. This grass may be valuable for Kenya conditions, and 2 lb. of seed has been collected for trial. Dr. Pole-Evans was in agreement that under Kenya conditions *Cynodon* species were likely to be suitable for a wide range of conditions (except at the highest altitudes), and that selection and collection of the strains of these was a very important problem. Other species of interest for Kenya were *Echinochloa pyramidalis, Panicum* sp. (Koomatipoort strain), *Paspalum urvillii,* and *Acroceros macrum.*

Breeding and Selection Work

At the Prinzhof Pasture Research Station selection and hybridization work are in progress and strains of species such as *Phalaris tuberosa* and *Bromus inermis* have been isolated. Seed of selections of these two varieties has been collected for trial in the high-altitude areas of Kenya. The large numbers of strains of Rhodes grass established indicate that some are considerably longer lived than others, and it may be possible to select a type from these more suitable for permanent pasture. The methods used in grass breeding work were also seen, and the very wide segregation from the progeny of selfed types, particularly in *Panicum* sp., was observed.

Establishment and Treatment of Artificial Pastures

The establishment of artificial pastures was seen at Rietondale, University Farm, Pretoria, Frankenwald, Leeuwkuil, and Hartebeestepoort. At this last station the grasses were irrigated during the periods of low rainfall. The chief established types were Rhodes grass and strains of Woolly Finger, and more recently Makarikari. At Hartebeestepoort, however, Kikuyu grass was the chief species in the established paddocks.

It has been found that Australian Rhodes grass is essentially a short-lived grass, suitable for short-term leys, and that its productive life can be prolonged

by heavy applications of organic manure and compost and to a lesser extent by the application of nitrogenous and phosphatic fertilizers. It has been shown that in the first two years of its life it is a highly productive grass.

Woolly Finger grass strains have proved to be much longer-lived than Rhodes grass, although their productivity also may decline with increasing age. Their value for winter grazing is high under South African conditions, and it is often recommended that paddocks of it should be reserved for this purpose. Management in the first year after planting has proved to be of great importance, and the fact that these established grasses will not stand mismanagement or heavy overstocking in the first year was clearly demonstrated in an experiment at the University Farm at Pretoria. Undoubtedly some of the most promising pastures seen were those at Leeuwkuil planted with Makarikari, but it is important to note that these were only in their first year, so that soil aeration was good, and they had also been well manured with organic manure. It has been found necessary at this station in some cases to grow green manure crops or to manure very heavily before establishing artificial pastures in order to raise the level of fertility. No work has been done on folding animals over the land so as to effect this and so to reduce the high cost of transport of compost and manure.

At Hartebeestepoort, where land is valued at a high figure per acre owing to the cost of irrigation water and the fertility of the soil, Kikuyu grass pastures had been established and these had been exceptionally productive for a period of two years, but this year when visited their productivity had fallen to a low level. This is probably due to lack of aeration in the soil consequent on irrigation, and it was felt that it could be corrected either by ploughing or by improving the humus status of the soil by the addition of organic matter. Fertilizers had had little effect alone. In this area attempts are being made to evolve a system of alternate husbandry with high-yielding grassland rotated with arable land for the cultivation of maize, wheat and tobacco, and it is probable that the finger grasses or Rhodes grass will prove superior to Kikuyu on account of the greater ease with which they can be eradicated when they are ploughed up. All the established grass species, including Napier (elephant) grass (*Pennisetum purpureum*), were producing low yields several years after planting, evidently because of lack of soil aeration.

All this work serves to stress the fact that artificially established pastures must be treated essentially as arable crops, with regard to both manurial and cultural treatments. The great importance of humus is stressed, and the fact that in the absence of a high humus content the application of artificial fertilizers is not generally an economic proposition. It has been shown, however, that artificial manures are more likely to yield an economic return when applied to established pastures rather than veldt, since veldt is not a medium capable of utilizing these manures to the best advantage and converting them into an economic return expressed in the form of meat or milk.

Veldt Management Experiments

These experiments were of very great interest, since they include all the various problems connected with veldt management, and although the plant successions on the veldt are different from those in Kenya and also the mixture of species is much greater, yet many of the methods of experimentation might well be applied to Kenya conditions.

The problem of the rapid incursion of bush is acute in many areas, for apart from the area that it occupies it renders the conservation of veldt grass in the form of hay or silage very difficult. Various methods are used for its eradication, including hand labour or grubbing with tractors, both of which are expensive, and the method of frilling and the insertion of poison is often preferred. This method is as follows: The bushes or trees are frilled near the base and poisonous solutions are inserted into the frilled area; these poisons may be either of the two following:—

(1) 4 lb. arsenic pentoxide, 1 lb. glue, per gallon of water.

(2) 10 per cent solution of sodium chlorate.

A newer and cheaper method has been elaborated by Dr. Scott, of the Estcourt Research Station, but as the results of these experiments are not yet available I do not describe the method here, although Dr. Scott has given permission for experiments to be carried out with it in Kenya without awaiting the publication of his results. The method is very simple and very cheap in cost.

In every case it has been necessary to find out how the plant succession may be altered by stocking and how the maximum utilization may be made of the grazing available. It is generally estimated at the present time that on the average farm only about 20 per cent utilization is made of the veldt grazing, due largely to lack of management and failure to conserve excess herbage. At the same time it has been pointed out that over-fencing and close paddocking of veldt may be as harmful as too little fencing since it may lead to excessive concentration and rapid deterioration of the herbage.

(Part II of this article, dealing with work on grassland and veldt management at the University Farms, the Warmbaths Pasture Research Station and the Leeuwkuil Research Station, Vereeniging, will appear in the November number.)

A HEADACHE FOR SURVEYORS

"*Land Measure.*—This is almost universally done by the Scotch ell of 37 $^{1}/_{5}$ English inches, and its denominations are—

6 ells Scotch (equal to 18 $^{6}/_{10}$ feet) make a lineal fall.
36 square ells (equal to 38 $^{44}/_{100}$ yards), 1 square fall.
40 square falls make one rood.
4 roods make one acre.

"This statute Scotch acre contains 5,760 Scotch ells, or 6,150 $^{4}/_{10}$ square English yards. Among the gardeners in the vicinity of Aberdeen, land was formerly let by the 100 beds; but it is now the practice to measure by the Scotch chain of 74 $^{4}/_{10}$ feet. Some land-measurers, very improperly, use a chain of only 74 feet. This makes the acre too little by 593.6 square feet, or one ninety-third part of the whole. This is a very dishonest practice; because the Scotch inch, though not now in use, was 1/185th part longer than the English inch, and the Scotch ell, of 37 Scotch inches, was found at the Union of the two kingdoms in 1707 to be 37 $^{1}/_{5}$ inches, or one-fifth part of an inch longer on the 37 English inches.—The Scotch acre is to the English as 38.44 to 30.25, being the proportion of the number of square feet in a Scotch or English *fall* or *perch*. This is very nearly as 61 to 48, as formerly mentioned."

—*General View of the Agriculture of Aberdeenshire*, 1811.

REVIEWS

THE RAPE OF THE EARTH, by G. V. Jacks and R. O. Whyte; Faber & Faber, Ltd., London; 1939; 21/-.*

Under the auspices of the Imperial Bureau of Soil Science, the same authors recently gave us a most useful world review of the state of soil erosion. As students of the soil they are trying to blow up the fortress of thought hitherto manned predominantly by politicians, financiers and economists, and they have now produced this masterpiece. It deals fully with the physical, historical, technical and economic aspects of man-accelerated erosion, and leads the reader deep into the philosophy, into the very spirit of this appalling result of the spread of succeeding civilizations into new regions of the earth. It attempts, on the whole successfully, to find a way out by a careful analysis of historical and social causes. In doing so the authors show how civilizations have fallen, or as in the case of China are falling, through the repeated neglect of the very foundation of all life—the land.

It is impossible, even in a lengthy review, to do justice to a book which on every page—in every line almost—bristles with statements of importance and is full of gems that in bold print ought to adorn the walls of offices, studies and bedrooms the world over. Thus, on page 19 we read, "Soil erosion is altering the course of world history more radically than any war or revolution." On page 36, "Erosion and erosion control are essentially problems relating to the maladjustment of human communities to their environment, i.e. they are fundamental problems in human ecology." "The only way to combat erosion is to work faster than it does, and this becomes increasingly difficult as time goes on" (p. 82). "When the user of the land speculates he is up against much bigger odds than the financier, and is a more dangerous fellow to the community at large" (p. 93). "Wherever the soil-conservation side of agriculture has been neglected for the sake of economic opportunity its reintroduction will mean that somebody must suffer a reduction in immediate profit" (p. 109). "An outstanding feature of the modern outlook on soil conservation is the emphasis laid on the superior value of biological, as compared with mechanical, control" (p. 111). "It is for the Administration to act not through the slow process of education but by the introduction of measures directed towards the early removal of the adverse factors" (p. 176, a citation from Professor Stebbing). "Having to a certain extent tamed the native races the only justification for the European to remain in Africa is to tame the vegetation" (p. 249). "What better use for South African gold could be found than to bury it again in the surface soil" (p. 266). And finally, "When the struggle for existence ceases to be a struggle for markets and becomes a struggle for water, the power of the country in relation to that of the towns will increase. The men who rule the rivers according to the way they manage the land, will rule the nation" (p. 297). And so on throughout the pages.

The account in this book of the dangers of soil erosion, of its causes and extent, and of ameliorative or protective measures taken or contemplated, is of necessity largely based on official publications. If in some cases, as for instance in Tanganyika Territory, the seriousness of the situation is, in my opinion, not sufficiently

* In order to assure as wide publicity as possible in East Africa for this remarkable book, the same review, with the consent of both editors, will also appear in the next number of *Tanganyika Notes and Records.*

emphasized, no blame for this can be attached to the authors but rather to too favourable reports. Thus, for example, it is not very helpful to minimize the dangers because soil erosion is only noticeable in one-tenth of the land (p. 69), the remainder being looked upon as land reserves. For not only does this figure not coincide with the facts, if account is taken of the rapid spread of as yet "occult," incipient deterioration, but the so-called reserves are not reserves until ways and means can be found to provide water and to drive out tsetse and tick. That we are still far from this desirable goal no one should dispute.

The book, its often gruesome facts notwithstanding, strikes on the whole a note of hope and thereby counters the indolent defeatist who is wont to appease his conscience by saying, "If soil erosion really exists then mankind must either die rapidly of starvation or a little more slowly of erosion." It does so by emphasizing the possibilities of final victory over nature through research in every direction, more particularly by ecological studies of plant succession, both natural and man-created, and through applying the results of such research, if necessary by revolutionary processes, to adapt the ever-growing masses of humanity to the dictates of soil fertility. That mere reliance on artificial fertilizers is not a panacea against soil mining, and that many fundamental changes in land tenure must be brought about, is made amply evident.

Chapter XIV, with its lucid statements regarding the primary importance of water conservation, particularly pleases me by the authors' thorough understanding of, and their constantly recurring emphasis on, the interrelations between soil, water and vegetation. They endorse fully my own views in a field I have long since made my own.

The outstandingly interesting chapters on the political and social consequences of soil and water deterioration bring out the dependence of civilized societies on securing and maintaining control of water and soil, and show that, for the grasslands at least, and even in such advanced communities as the U.S.A., a return to something like communal or collective planning and land tenure may become inevitable. This will, no doubt, provide food for thought to those who believe in a development towards individual land tenure for the African native, and away from firmly established collectivism, as a means for stemming soil erosion. Especially Chapter XX, dealing with African problems, is full both of excellent truths and debatable suggestions; we in Africa ought to re-read it at frequent intervals. The "feudalism" of a white upper stratum and African serfs which the authors foreshadow (pp. 261-2) might conceivably take the more humane form of European guidance of free peasants by "syndicates," of which a successful example exists at the Gezira in the Sudan, and which I have for long looked upon as a feasible, just and promising solution deserving further experimentation.

Another point on which one might disagree is the following: Given that international capitalism, which "enriched mankind and impoverished the earth" (p. 215), is primarily to blame for the unprecedented recent deterioration of the soil (Chapter XVII contains many striking proofs for this), need one therefore endorse the view that "economic nationalism," which can and does apply the screw, is the only "medium," though admittedly "strong and unpalatable"? Cannot less drastic and more humanely cosmopolitan ways be found to adjust a civilization born and bred in a humid and temperate environment to that of the sub-humid and semi-arid grasslands, or

to the even more difficult conditions of the tropics? Unless they can it may, at least to some of us, be preferable "to die slowly of soil erosion". The astonishing efforts made during the last few years in the U.S.A. towards a corporate society which voluntarily accepts the restrictions of individual freedom regarding soil and water, so ably described by the authors (e.g. on pages 231, 235, 242 and 296), would seem to point the way towards a more hopeful solution.

In this connexion just two more queries: Would the totalitarian states, were they to regain a footing in the semi-arid lands, really improve matters, or would they not rather by the very principles of their totalitarianism suck these areas even drier, and at a pace much faster, than capitalism does or ever has done, in Africa for instance? And do the authors themselves not rightly proclaim—in Chapter XVIII, which contains many valuable remarks on this important subject—that this "world-wide problem must be tackled as a whole, as otherwise soil conservers would be placed at an immediate economic disadvantage in relation to soil exploiters" (p. 222)? That statement would seem to show that a world divided between international capitalism and economic nationalism will not solve the problem, even though the latter may be gaining ground.

A consideration of the future trend of events, sketched in the last chapter, sees in the wave of nationalism that has been raging since the war the first and unavoidable phase towards a reconstitution of soil balance which, in the authors' opinion, can only be achieved by the universal terror of war. Although it is difficult to follow this argument cheerfully to the promised end, it cannot be denied that, unfortunately, there is a good deal of truth in it (pp. 284-5).

Only mere mention can be made of the admirable expositions on erodibility (p. 94), on the pros and cons of veldt and forest burning (p. 148), on the beneficent influence of forests (pp. 159-160), and above all of the present and future development of grasslands, especially as planned by the Russian experiment (pp. 289-91), the last being summed up in the truly philosophical statement, "The present civilization has desiccated the forests; the next will moisten the grasslands. We can only guess how that triumph will ultimately be achieved." The pictures adorning the book are excellent and well chosen. And only one slip has been noticed, on page 68, where the dry savanna forest of Northern Rhodesia is called "primeval".

It is not going too far if one advocates that this admirable treatise should be available for constant reference to everyone concerned with the future of our civilization, and more particularly to those who see salvation only in the investment of more capital, the dividends on which will inevitably have to be paid, under present conditions, in loss of soil fertility. Especially European settlers of the semi-arid new-lands might take to heart the pungent but fair criticism of their "limitless optimism" and of the attitude of mind it is based on (p. 292).

This book might well be regarded as the bible of modern man.

C. GILLMAN.

CONTROL OF SMUT DISEASES—A REVIEW OF RECENT LITERATURE

By G. B. Wallace, B.Sc. (Agric.), Ph.D. (Edin.), Plant Pathologist, Department of Agriculture, Tanganyika Territory

Since the publication of information [3] [4] [5] by East African Departments of Agriculture on control measures for smut diseases by seed treatment, a certain improvement has been reported. The methods, whether by dipping the seed in dilute formalin or copper sulphate solutions or by dusting with sulphur, are simple and economical. When, however, very considerable control can be effected at no cost at all, by modification of planting conditions, this is to be preferred. We welcome the publication of data on experimental work in the U.S.A. and in Egypt along these lines.

Two members of the Mycological Section of the Ministry of Agriculture, Cairo, Messrs. G. H. Jones and Abd el Ghani Seif el Nasr [1] have observed that both depth of planting and degree of soil moisture affect the amount of certain cereal smut diseases (Flag Smut and Bunt of wheat, Covered Smut of barley and Grain Smut of millet—of which the latter two occur in East Africa). Briefly, in the Egyptian experiments, sowing at a depth of ½ cm. resulted in little smut; at 4 cm. there was a very rapid rise, particularly of Grain Smut of millet (25 per cent compared with 2 per cent); at 4 cm. and greater depths a moist soil gave higher percentages of disease than wet soil.

The results have particular application in irrigation countries where a "mud sowing" method of sowing the seed on the surface of soaked soil can almost eliminate disease. But the significance of shallow planting should be investigated under East African conditions. The authors state that a full account of this and related subjects will be published as a "Scientific Bulletin" of the Egyptian Ministry of Agriculture.

Other useful information is given in an article entitled "The influence of environmental conditions at planting time on sorghum kernel smut infections," by L. E. Melchers and Earl D. Hansing [2] in Kansas. After a summary of previous literature, the authors describe their five years' work; some of their conclusions are as follows:—

> Soil temperature and soil moisture are interdependent factors in determining infection by kernel (or grain) smut.
>
> Medium to low soil temperatures with medium to low soil moistures seem to be conducive to the maximum infection.
>
> Heavy infections occur at any temperature below 75° F. (24° C.) that allows the seed of Kafir to germinate In general, when the mean maximum temperatures during the infection period are 75° F. or above, the amount of infection is reduced.
>
> Soil moistures of 28 per cent or more on the dry basis reduce the infection considerably, even though favourable soil temperatures prevail.
>
> Slightly acid soils are the most favourable for high infection (see also *American Journal of Botany*, 11, 518-534 and 579-599).

The above information should prove of interest to those in sorghum areas, where Grain Smut is one cause of considerable loss. The application of the data would require to be tested under local conditions and, if successful, the modifications in planting practice demonstrated to native growers.

There appears to be no evidence that Loose Smut of sorghum is affected by

these measures. Unless it also is controlled, seed treatment must remain the normal means of control where this disease occurs.

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LETTER TO THE EDITOR

SEPARATED MILK FOR POULTRY

Sir,

In the "Notes on Feeds and Feeding" in the May issue of your Journal, in the first paragraph on poultry feeding on page 446, Mr. Ball very rightly draws attention to the deficient nature of a ration composed of maize and skim milk only, and recommends adherence to the methods of feeding balanced mashes.

I have been working recently on the value of separated milk for poultry feeding and the results indicate that separated milk can supply the animal protein required by a balanced ration just as efficiently as meat meal. In an actual trial the separated milk group gave 9 per cent higher egg returns than when meat meal formed the sole source of animal protein. In the feeding of young stock its value is firmly established.

My object in raising this matter is to draw the attention of farmers to the great value of separated milk for poultry feeding, provided it is fed judiciously. Certain farmers might imagine, since a ration of maize and skim milk has been found unsuitable, that milk stands condemned as a poultry food. Only this week, when describing my own results, I was asked to explain why it was that in other trials skim milk had not given such good returns and I was referred to the above article. It is the combination of maize and skim milk when fed alone to poultry that Mr. Ball condemns, not the individual foods. Both are wholesome and valuable foods if fed properly. In East Africa, heavy transport charges on top of the purchasing price may make meat meal very expensive. When this happens, and also when large quantities of separated milk are available, it will pay farmers to use separated milk instead of meat meal for balancing their poultry rations.

Your obedient servant,
M. H. FRENCH,
Chemist.

Department of Veterinary Sciences and Animal Husbandry,
Mpwapwa, Tanganyika Territory,
12th June, 1939.

WEEDS OF HIGH-ALTITUDE DISTRICTS IN UGANDA

By G. B. Masefield, M.A., A.I.C.T.A., Agricultural Officer, Uganda

The notes that follow are based on observations made in the Kigezi[1] and Bugishu districts, which are similar in many respects though they are at opposite ends of Uganda. In both districts there are areas of short-grass plains at lower altitudes which are not under consideration here; in both there are also extensive cultivated areas at altitudes of between 5,500 and 7,000 feet. These two high-altitude regions are among the most densely populated parts of Uganda, and both carry also very heavy live stock populations. Little forest is left in the cultivated parts, and the vegetation consists of heavily grazed scrub and grassland. The grasslands of Kigezi have been described as the finest pasturage in Uganda.

Let us consider first the grasses that come into prominence as weeds. Kikuyu grass (*Pennisetum clandestinum*) quickly spreads along paths and the sides of cattle tracks; *Eleusine indica* (Luganda, *kasibanti*) is another common path-side weed. *Cynodon plectostachyum* (Luganda, *kalandalugu*) is also very common where cattle tread, and together with with *Digitaria scalarum* (Luganda, *lumbugu*) is the chief invader of cultivated plots. *Lumbugu*, however, is not at these altitudes such a troublesome weed as on the plains; it seems to spread less quickly and to be easier to eradicate.

Amongst non-grassy weeds, *Galinsoga parviflora* of the Compositae is outstanding for its abundance; it is known as "Macdonaldi" to Europeans, as *mpunica* in the Lukiga language of Kigezi, and as *ndege* or *nandege* in Lugishu. In both districts there is a tradition that this weed has been introduced into the country through European farms (though none exists in either of the areas referred to), and the Bagishu have a theory that the seeds were carried from Kenya by birds, hence the vernacular name. Agriculturally this is, of course, well known as a comparatively harmless weed and is sometimes favoured as a cover crop.

Another weed of the same family, *Bidens pilosa* (Luganda, *sere*), which is very common at lower altitudes, occurs only sparingly in these regions. Other common composite weeds are *Spilanthes acmella*, a small creeping plant (in Bugishu), and a small *Ageratum*.

The weeds that, with *lumbugu*, are generally considered the most troublesome are species of *Commelina* and *Aneilema*, known collectively in Luganda as *nanda*. Other common and easily recognizable weeds include *Leonotis africana, Plantago palmata, Justicia flava* (in Bugishu), and species of *Amaranthus, Ipomoea, Carex*, and *Leucas*.

There are a few weeds which deserve special notes. The only parasitic weed I have seen in these areas is *Orobanche minor* (a broom-rape), which occurs in pastures in Kigezi. A weed whose position is interesting is bracken (*Pteris aquilina*); although it occurs at quite low altitudes in Uganda, it is not a serious weed below about 6,000 feet, above which it is sometimes the prime invader of abandoned plots. The English potato is not often thought of as a weed, yet it is

[1] Kigezi is a hill country, mainly of Karagwe-Ankolean shales and quartzites, with a smaller extent of volcanic rocks and some granites, in the extreme south-west of Uganda near the Congo and Ruanda borders. Bugishu is the slopes and foothills of Mount Elgon on the Uganda side, next the Kenya border; its rocks are mainly volcanic.—*Ed.*

quite extensively grown by natives in Bugishu and Kigezi and the smallest tubers are not removed from the soil, so that it springs up as a weed in the most unexpected places, including coffee plots and the middle of roads! A weed not common on cultivated plots but which sometimes forms a pure stand in black wattle plantations in Kigezi is *Achyranthes aspera*. Perhaps the most attractive of all the weeds of these areas is the "blood flower," *Hæmanthus multiflorus*, which is occasionally found in finger-millet plots in Bugishu.

So far the list has mentioned chiefly weeds that are liable to occur in any plot where the hoeing has been left a bit too long, but there are also a variety of plants, mostly of larger size, that make their appearance if a plot goes out of cultivation for a longer period. Amongst these we may list *Rumex abyssinicus* (a sorrel), *Gynura vitellina, Phytolacca dodecandra* (giant poke weed), *Wedelia oblonga, Galium aparine* (bedstraw), and species of *Sida, Coleus, Kalanchae, Vernonia, Cyathula, Dicrocephala.*

This leads to the question of succession of weeds on abandoned plots, but undisturbed successions are rarely observed owing to the heavy incidence of grazing and burning. The flora that may develop in such circumstances is very rich, including most of the species of the surrounding country, and it is obviously impossible to detail it here. It may be of some interest, however, if I select from a list of plants growing on a hillside in Kigezi on old cultivated land those that contributed the greater bulk of vegetation, placing them in several classes:—

Shrubby.—Geniosporum paludosum, Microglossa densiflora, Lantana trifolia, species of *Acanthus* (locally dominant), *Vernonia, Pycnostachys, Coleus.*

Legumes.—(1) Shrubby: Species of *Crotalaria, Indigofera, Tephrosia*; (2) Herbaceous: Species of *Desmodium, Centrosema, Trifolium, Vicia.*

Grasses and Sedges.—Hyparrhenia dissoluta (locally dominant), *Setaria sphacelata* (locally dominant), *Digitaria velutina, Sporobolus* sp., *Pennisetum clandestinum, Digitaria scalarum, Pennisetum purpureum* (local; usually near water), *Kyllinga* sp.

Other Herbs.—Wedelia oblonga, Gynura vitellina, Helichrysum fruticosum and *H. setosum, Pentas carnea, Phytolacca dodecandra,* species of *Ipomoea, Commelina, Coreopsis, Micromeria, Borreria, Justicia, Erlangea.*

The last aspect that remains to be considered is the methods used by the peasant in combating these weeds. Normally he relies on the hoe, but the finger-millet crop is usually weeded by hand by the women. In both these districts mulching with either grass or plantain leaves is now the usual practice for coffee, only a minority of plots being untreated. Mulching is the practice also with the other perennial crop, plantains. In both crops it helps to keep weeds at a minimum.

NOTES ON ANIMAL DISEASES

Compiled by the Department of Veterinary Services, Kenya Colony

V—MALIGNANT CATARRH

Malignant catarrh is an infectious disease of cattle characterized by a mucopurulent discharge from the eyes and nose and by rapid loss of condition. In Europe four forms of the disease are recognized, the peracute form, the alimentary form, the head and eye form, and the mild form. In Kenya, the head and eye form and the mild form occur.

The head and eye form is a clinically well marked condition that in Africa is usually, if not always, associated with the presence of wildebeest. The Masai believe that the disease is contracted by cattle when they graze over ground contaminated by the after-birth of a calving wildebeest, or alternatively over ground upon which a wildebeest calf has lain and shed its coat. Outbreaks of the disease certainly occur on farms on the Athi Plains and in the Masai Reserve during June and July; that is, shortly after the calving season of the wildebeest.

The mild form has a much wider distribution, and has been seen on farms where contact with wildebeest cannot occur. It would appear that wildebeest may be capable of transmitting the disease to cattle even though they show no signs of infection themselves. It is possible therefore that cases occurring in areas where there are no wildebeest may be attributed to infection obtained from other species of antelope or even from sheep.

In Europe, sheep are believed to harbour the disease without showing symptoms, and are reputed to cause infection in cattle.

Symptoms.—Head and Eye Form: In experimental cases the period from inoculation to the first rise in temperature varies from 14 to 60 days. Catarrhal symptoms may be noticed three or four days before the first rise of temperature, and it is probable that animals in contact may contract infection during this time. Death usually occurs from four to ten days after the temperature becomes elevated.

In the early stages, a watery discharge from the eyes and nose is noticed. This gradually thickens, and the discharge from the eyes dries as a large bead of material at the inner angle of the eye. The eyes are obviously affected by strong light and in the final stages the eyes become opaque. The discharge from the nose forms strings of thick, ropy, yellowish mucus, which for a time drip to the ground; but later become so tenacious that they adhere to the nostrils and cake around the muzzle. The skin of the muzzle peels and obstruction of the nasal passages causes difficulty in breathing.

At the beginning of the temperature reaction the inside of the mouth appears red. In some animals this congestion later disappears; but more frequently an eruption, indistinguishable from that of rinderpest, develops on the gums, inside the cheeks and on the roof of the mouth.

An almost constant feature is swelling of the superficial lymph glands. At the time of death the glands are frequently larger than in cases of east coast fever.

Diarrhoea is rarely observed.

In the final stages, loss in condition is very marked, although up to the last two or three days the appetite is maintained. Nervous symptoms are frequently present shortly before death, a tendency to charge the observer when approached being not uncommon.

Mild Strains.—With the mild strains symptoms generally resemble those of the head and eye form, but are not so marked nor so consistent. In addition, skin lesions are often displayed. These take the form of thickening and peeling of the skin of the neck, in the armpits and under the tail. In the less acute cases the hæmolymph glands are swollen. These glands can be felt most easily half-way down the side of the neck as a chain of several hard pea-like objects under the skin. In cases that recover, these glands may be palpated for several months.

Post-mortem Lesions.—In addition to the head lesions that can be seen during life, changes are found in many organs. The liver and kidneys are larger than normal and their surface is mottled with fine grey spots. In some animals infarcts resembling those of east coast fever are present in the kidneys.

In spite of the similarity of the mouth lesions to those of rinderpest, changes suggestive of rinderpest are rarely present in the remainder of the alimentary tract. Pin-point hæmorrhages and small ulcers are occasionally seen in the fourth stomach, but they never form a severe lesion and the intestines are usually normal throughout.

The lymph glands are swollen, and on section the gland tissue may contain cherry-pink areas or may be entirely pink. The cut surface appears granular even if unchanged in colour. Characteristic lesions are almost always found in the brain. On opening the cranium the brain looks as if it has been cooked and has an odour somewhat resembling that of broth.

Causes.—Malignant catarrh is almost certainly caused by a filtrable virus. Up to the present, proof of filterability has not been obtained. The causal agent does not possess any great powers of resistance *in vitro,* and accordingly does not stand the ordinary laboratory manipulations at all well; possibly, like the virus of rinderpest, it is present in the body attached to certain types of cells.

Animals Affected.—Naturally contracted clinical cases of the disease are only seen in cattle. Experimentally, a very mild form may be induced in sheep, and on inoculation rabbits develop typical symptoms.

Transmission.—Malignant catarrh is a contagious disease. It does not, however, spread rapidly, and outbreaks usually die out naturally.

Mortality.—With the head and eye form the mortality in clinically affected cattle is very high. As the incidence is low, however, the losses in the herd are usually small. Exceptionally, a heavy herd mortality is experienced in Masai *manyatta.*[1]

Prevention.—No method of immunization has been elaborated. Affected animals should be isolated as soon as they are noticed to be sick. In areas where herds of wildebeest exist, cattle should, when possible, be kept off the grazing used by the wildebeest and especial care should be taken during the time that the wildebeest are calving.

[1] *manyatta*=cattle-kraal.

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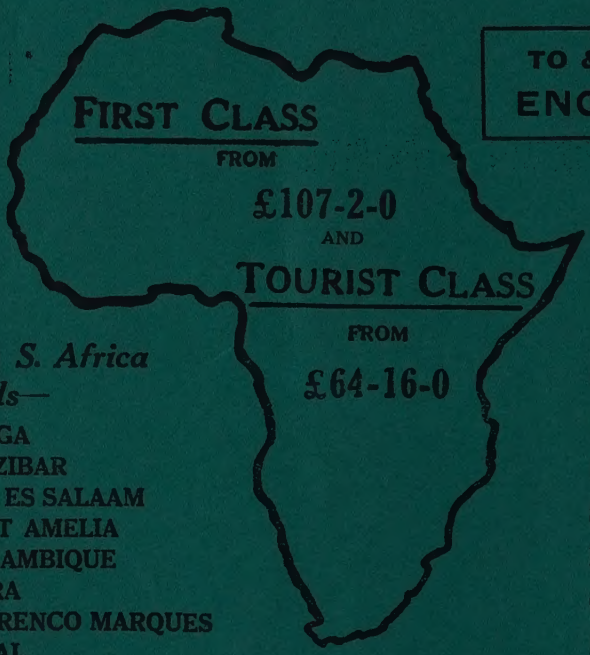

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